

Commonwealth of Virginia
Department of Environmental Quality



**PRELIMINARY DATA REPORT
AMBIENT AIR TOXICS MONITORING PROJECT
HOPEWELL, VA
2006 - 2008**

Division of Air Quality
Office of Air Quality Monitoring
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Some information in this report was quoted from the National Air Toxic Assessment (NATA), Toxicology Data Network (TOXNET), Occupational Safety and Health Administration (OSHA), Agency for Toxic Substances and Disease Registry (ATSDR), and Hazardous Substances Data Bank (HSDB), and the Virginia Annual Reports.

Acknowledgment:

We would like to acknowledge and thank EPA Office of Air Quality Planning and Standards (OAQPS), EPA Region III, Hopewell City Council, Hopewell City School Board, Virginia Commonwealth University (VCU), Division of Consolidated Laboratory Services (DCLS), and DEQ Piedmont Regional Office.

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1.0. BACKGROUND:

In 2006, the Virginia Department of Environmental Quality (VADEQ) applied for a special grant to establish and operate a comprehensive Air Toxics monitoring project in the Hopewell area. The Office of Air Quality Planning and Standards (OAQPS) of US Environmental Protection Agency (EPA) awarded VADEQ funding for this short term study. The project enabled VADEQ to perform ambient air sampling in the Hopewell area for a limited number of air pollutants classified as toxic air pollutants in the Virginia Regulations for the Control and Abatement of Air Pollution. The collected data and subsequent data review have been provided to the DEQ Risk Assessment office to provide additional information for the risk analyses to be performed as a result of this study.

2.0. OBJECTIVES:

In order to better understand the air quality and health aspects of selected ambient air toxic pollutants in the City of Hopewell, the project was designed to address the following objectives:

- To establish a baseline for ambient air exposure of hazardous volatile organics in this communities and help to identify the potential existence of “hot spots”.
- To obtain information that will assist in the development of the residual risk standards since most of the sources involved are covered by at least one Maximum Achievable Control Technology (MACT) standard.
- To characterize main pollutants by determining spatial concentration patterns and the major sources of the pollutants in the Hopewell/Colonial Heights area that could be used to evaluate future emission control programs.
- To assess the validity of the National Air Toxics Assessment (NATA) findings.
- To quantify and evaluate background diesel particulate matter (diesel PM) by using black carbon data collected from an Aethalometer purchased for the project.

3.0. SUMMARY:

This report summarizes the sampling activities for air toxics monitoring conducted from December 2006 to September 2008 in Hopewell. The report also summarizes data analyses performed by the Office of Air Quality Monitoring (AQM) for samples collected at three monitoring sites: C.G. Woodson Middle School, Spruance Street, and VCU’s Rice Center in Charles City County. The analyses indicated that the pollutants concentrations in the air samples collected from this study were not appreciably different from sample concentrations collected from other ambient air toxics monitoring sites in Virginia. The study also found some differences between the concentrations predicted by the 1999 NATA study and the data found through these monitoring efforts. A follow up risk assessment is tentatively planned by Dr. Alan Anthony of VADEQ. The study has established a range of air quality concentrations for the Hopewell area, which will be useful for evaluations and comparisons with any future National Air Toxic Assessment (NATA) studies.

4.0. AMBIENT AIR SAMPLING ACTIVITIES:

4.1. STAKEHOLDER COMMITTEE:

In order to facilitate communication of the results for the project, a stakeholder committee was set-up. This committee contains representatives from government, education, industry and the Hopewell Citizenry. The members of the stakeholder group are as follows:

- **Local Representatives:**

Christina J. Luman-Bailey	City Council
Brenda S. Pelham, Vice Mayor	City Council
Ray Watson, Assistant Superintendent	Hopewell Public Schools
Phillip E. Elliott, Director	Public Works Department
Curtis R. Holsopple, Ph.D.	Citizen

- **Organizations:**

Chuck Bogatie	Hopewell Community & Industry Panel
Mr. Joe S. Furr, Jr.	Smurfit-Stone Container Corp.
L. Evans Drake	Honeywell – Hopewell Plant
Dr. Leonard Smock	VCU – Rice Center
David Debiasi	Community Relations, American Lung Association
Dr. Michael O. Royster	Crater Health District

- **VADEQ:**

James Dinh	Office of Air Quality Monitoring
Brian King	Office of Air Quality Monitoring
Baxter J. Gilley	Office of Air Quality Monitoring
Dr. Alan Anthony/ Pat McMurray	VA DEQ
Angela Neilan	VADEQ

4.2. POLLUTANT SOURCES:

Hopewell city is a highly industrialized area. The city has numerous stationary point sources including medical, industrial and commercial facilities along with on-road mobile sources (motor vehicles) within its boundaries. Stationary point sources in the area emit several volatile organic compounds (VOCs) which are listed in the EPA list of Hazardous Air Pollutants (HAPs). In addition, mobile sources (on-road and off-road) from nearby highways and interstates such as: I-95, I-295, Route 36, and Route 10 could contribute a detectable portion of the air pollutant concentrations in the area.

4.3. SAMPLING LOCATIONS:

Data generated by this project will be used to conduct both a limited risk assessment for Hopewell and for comparison to the results of the 1999 NATA review. VADEQ operated three air toxics monitoring stations. Selection of the three toxic stations was made based on optimum spatial coverage, availability of sampling locations, and primary wind direction. The historic wind data for the Hopewell area indicated the primary wind direction is from the southwest.

- Upwind site. This site serves as a background monitoring site for the project.

Carter G. Woodson Middle School	N 37° 17' 26.3"
	W 77° 17' 24.2"

VADEQ also collected data for the characterization of PM Diesel at this location by measuring black carbon using an Aethalometer sampler.

- Primary (Central) site: This site is located in the residential area down wind from industries/point sources to measure potentially elevated concentrations of industrial / commercial air toxics emissions.

Spruance Street	N 37° 18' 43.8"
	W 77° 16' 22.6"

- Downwind site: This site serves as a measure of the transport of air toxics concentration for the project.

VCU Rice Center	N 37° 19' 55.3"
	W 77° 12' 30.5"

Figure 4.3.1 Map of Hopewell sampling locations

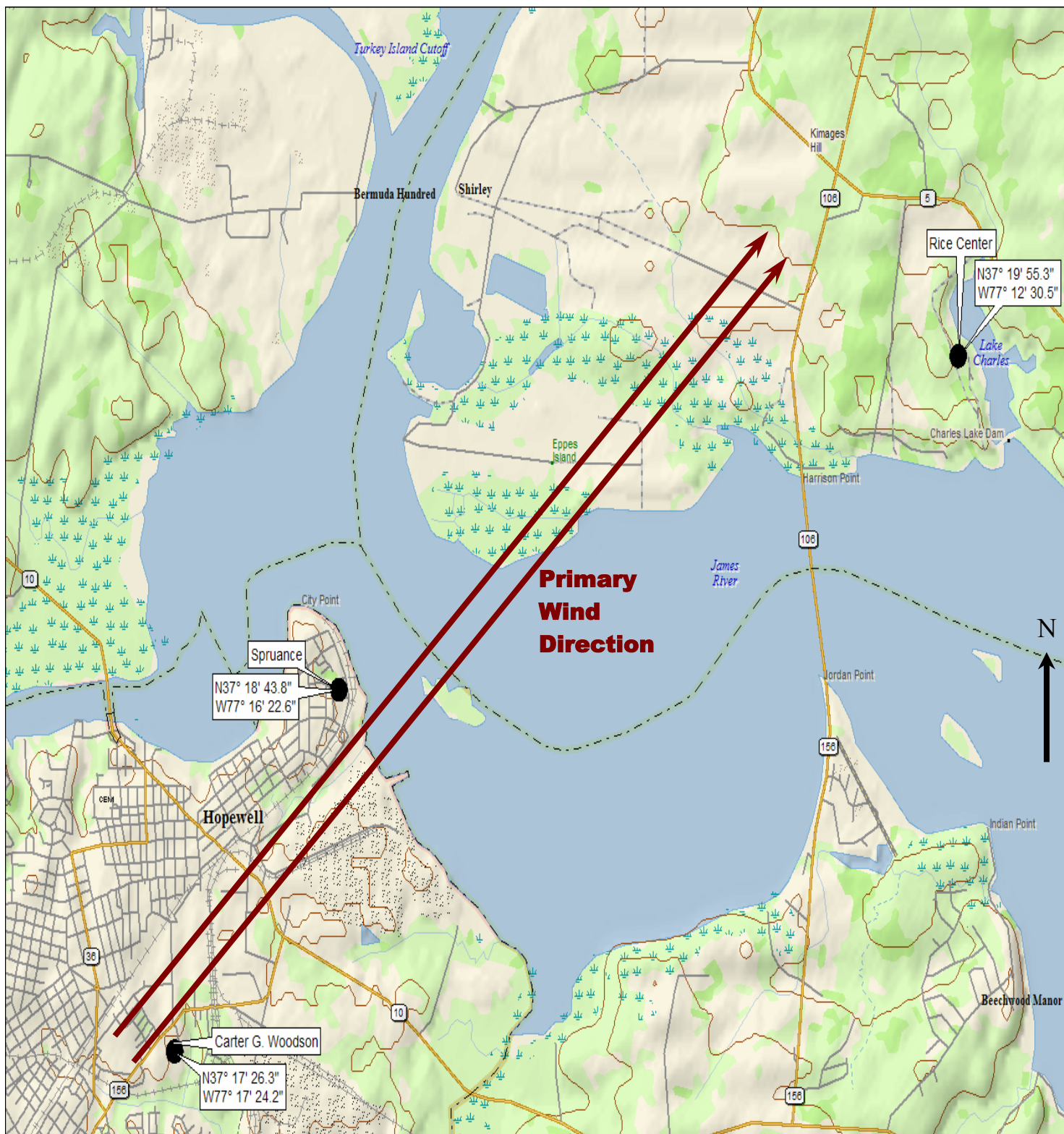


Figure 4.3.2 Pictures of Hopewell Project Sampling Sites



C.G. Woodson site



Spruance site



VCU Rice Center site



Inside a monitoring trailer

4.4. TARGET POLLUTANTS:

In order to assess the impact of motor vehicle, commercial and industrial emissions in the area, VADEQ collected ambient air samples and analyzed the collected samples for a number of Hazardous Air Pollutants (HAPs). Selection of these targeted HAPs was based on the likelihood of obtaining measurable results and the capability of the current analytical systems. These HAPs are identified in EPA's draft Integrated Urban Air Toxics Strategy (UATS). The target pollutants list is also a subset of the 188 toxics identified in Section 112 of the Clean Air Act (CAA).

These target HAPs were grouped into three types: volatile organic compounds (VOC), carbonyls, and air toxic metals.

Table 4.4.1 List of VOC's in TO-15 scan

	CAS #	AQS #	Pollutant Names	State Toxic/HAP (y/n)		CAS #	AQS #	Pollutant Names	State Toxic/HAP (y/n)
1	115-07-1	43205	Propylene	n	28	25-27-4	43828	Bromodichloromethane	n
2	75-71-8	43823	Dichlorodifluoromethane (Freon-12)	n	29	79-01-6	43824	Trichloroethylene	
3	74-87-3	43801	Chloromethane (Methyl Chloride)		30	80-62-6	43441	Methyl Methacrylate	
4	76-14-2	43208	1,2-dichloro-1,1,2,2-tetrafluoroethane	n	31	142-82-5	43232	Heptane	n
5	75-01-4	43860	Vinyl Chloride		32	542-75-6	43831	cis-1,3-dichloropropene	
6	106-99-0	43218	1,3-Butadiene		33	542-75-6	43830	trans-1,3-dichloropropene	
7	74-83-9	43819	Bromomethane		34	9-00-5	43820	1,1,2- Trichloroethane	
8	75-00-3	43812	Ethyl chloride		35	108-88-3	45202	Toluene	
9	107-02-8	43505	Acrolein		36	124-48-1	43832	Dibromochloromethane	n
10	75-69-4	43811	Trichlorofluoromethane (Freon-11)	n	37	106-93-4	43843	1,2-Dibromoethane	
11	75-35-4	43826	1,1-Dichloroethene		38	127-18-4	43817	Tetrachloroethene	
12	75-09-2	43802	Methylene chloride		39	108-90-7	45801	Chlorobenzene	
13	76-13-1	43207	1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113)	n	40	100-41-4	45203	Ethylbenzene	
14	540-59-0	43838	trans-1,2-Dichloroethene	n	41	108-38-3	45109	m & p-Xylene	
15	75-34-3	43813	1,1-Dichloroethane		42	75-25-2	43806	Bromoform	
16	1634-04-4	43372	Methyl tert butyl ether		43	100-42-5	45220	Styrene	
17	540-59-0	43839	cis-1,2-Dichloroethene	n	44	79-34-5	43818	1,1,2,2-Tetrachloroethane	
18	100-54-3	43231	Hexane		45	95-47-6	45204	o-Xylene	
19	67-66-3	43803	Chloroform		46	622-96-8	45213	1-Ethyl-4-methylbenzene	n
20	141-78-6	43209	Ethyl Acetate	n	47	108-67-8	45207	1,3,5- Trimethylbenzene	n
21	109-99-9	46401	Tetrahydrofuran	n	48	95-63-6	45208	1,2,4- Trimethylbenzene	n
22	107-06-2	43815	1,2-Dichloroethane		49	541-73-1	45806	1,3-Dichlorobenzene	n
23	71-55-6	43814	1,1,1-trichloroethane		50	106-46-7	45807	1,4-Dichlorobenzene	
24	71-43-2	45201	Benzene		51	95-50-1	45805	1,2-Dichlorobenzene	n
25	56-23-5	43804	Carbon Tetrachloride		52	120-82-1	45810	1,2,4- Trichlorobenzene	
26	110-87-7	43248	Cyclohexane	n	53	87-68-3	43844	Hexachloro-1,3-buadiene	
27	78-87-5	43829	1,2-Dichloropropane						

Table 4.4.2 – List of Carbonyl Compounds in TO-11a Scan

CAS #	AQS #	Pollutant Names	State Toxic/ HAP y/n
50-00-0	43502	Formaldehyde	y
75-07-0	43503	Acetaldehyde	y
123-38-6	43504	Propionaldehyde	y
107-02-8	43505	Acrolein	y
67-64-1	43551	Acetone	n
78-93-3	43552	Methyl Ethyl Ketone (MEK)	n
108-10-1	43560	Methyl Isobutyl Ketone (MIBK)	y

Table 4.4.3 – List of Toxic Metals

CAS #	AQS #	Pollutant Names	State Toxic/ HAP y/n
7440-38-2	82103	Arsenic and compounds	y
7440-41-7	82105	Beryllium and compounds	y
7440-43-9	82110	Cadmium and compounds	y
7440-47-3	82112	Chromium and compounds	y
7439-92-1	82128	Lead and compounds	y
7439-96-5	82132	Manganese and compounds	y
7440-02-0	82136	Nickel and compounds	y
18540-29-9	12115	Hexavalent Chromium (PM10)	y

4.5. SAMPLING FREQUENCY:

Sampling occurred every sixth day for all targeted pollutants. The once in six day schedule was chosen because it is more rigorous than the minimum of 1 in 12 day sampling, it coincides with the EPA required sampling rate for the PM10 monitors used at the sites and it is the highest frequency that could be used based on cost and manpower availability. The VOC & PM-10 collocated samples were collected every twelve days and Carbonyl collocated samples were collected during every sampling event. Collocated samplers are included in the study as a quality assurance procedure to verify results from routine samplers, to detect and identify spurious results and to ensure consistency in sample handling.

4.6. SAMPLING METHODS:

The goal of the VADEQ is to estimate the concentration of air toxic compounds of particulates and gases in units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). This is accomplished using canisters and four other separate collection media:

- Silco Canisters for VOC sampling (TO-15)
- Dinitrophenylhydrazine (DNPH) treated cartridges for Carbonyl sampling (TO-11a)
- Quartz filter (PM-10 high volume sampler) for Toxic metals sampling (IO-3)
- Sodium Bicarbonate treated filters (PM10 low volume sampler) for Hexavalent Chromium sampling
- Fibrous filter tape for Black Carbon by Aethalometer

4.6.1. Sampling Method TO-15:

VADEQ selected sampling method TO-15 to collect ambient air samples for VOC monitoring. This method is a standardized EPA method for the determination of Volatile Organic Compounds (VOC) in the air. This method is presently being utilized for the National Air Toxics Trends Stations (NATTS) and Urban Air Toxics (UAT) programs. The sample is collected in specially-treated stainless steel Silica lined (Silco) canister and analyzed by Gas Chromatography Mass Spectrometry (GC/MS). Sample collection can be conducted in two sampling modes: passive and pressurized. VADEQ adopted the pressurized sampling mode, which requires an additional pump to provide positive pressure to the sample canister.

4.6.2. Sampling Method TO-11A:

VADEQ selected sampling method TO-11A to collect ambient air samples for Carbonyl compounds (aldehydes and ketones) monitoring. This method is a standardized EPA method for the determination of Formaldehyde in ambient air using adsorbent cartridge followed by High Performance Liquid Chromatography (HPLC). The atmosphere is sampled by introduction of time-weighted average (TWA) air samples into a commercially available dinitrophenylhydrazine (DNPH) impregnated silica gel cartridges.

4.6.3. Sampling Method IO-3

VADEQ selected sampling method IO-3 to collect ambient air samples for toxic metals sampling. This method is used for analyzing the elemental metal components in ambient air particulate matter collected on high volume PM-10 Quartz filter. The collected PM-10 sample is analyzed by Inductively Coupled Plasma / Mass Spectrometry (ICP/MS)

4.6.4. Hexavalent Chromium Sampling Method:

VADEQ has modified the California 39 and ERG sampling methods for Hexavalent Chromium sampling. For the project, a Rupprecht & Paterashnick Partisol 2025 sampler was selected due to DEQ's experience with the instrument and its availability. We have converted the sampler from the form of a PM2.5 sampler to a Partisol-Plus PM-10 Sampler by removing the WINS impactor and installing a Pass Thru tube. Division of Consolidated Laboratory Services (DCLS) analyzed the Hexavalent Chromium component in ambient air particulate matter collected using a low volume PM-10 sampler on a 47mm Sodium Bicarbonate treated cellulose filter.

4.6.5. Aerosol black carbon sampling method:

VADEQ deployed a portable Magee AE-42 Aethalometer to measure aerosol black carbon (BC). The monitor uses a method of optical attenuation to develop its value of BC in a collected air sample.

4.7. SAMPLING EQUIPMENT:

The specific equipment used in the Hopewell special study project is as follows:

4.7.1. Air Canister Sampler - Volatile Organic Compounds (Method TO-15)

VADEQ used the RM ESI 910 PC Air Canister Sampler to collect whole air samples for VOC analysis. The sampler was made by RM Environmental System Inc., in Van Nuys, California.

4.7.2. Carbonyl Sampler - Aldehyde and Ketone Compounds (Method TO-11A)

VADEQ used the ATEC 8000 Carbonyl Sampler to collect whole air samples for Carbonyl analysis. The sampler is made by Atmospheric Technology Inc., in Calabasas, California.

4.7.3. Particulate Matter Sampler - Toxic Metals (Method IO-3)

VADEQ used the high flow PM-10 Particulate Sampler to collect whole air samples for Air Toxic Metal sampling. The sampler is made by Wedding and Associates Inc. in Fort Collins, Colorado.

4.7.4. Hexavalent Chromium Sampler

VADEQ has modified the R&P 2025 Particulate Sampler to collect whole air samples for Hexavalent Chromium sampling. The sampler is made by Rupprecht & Pataschnick Co. Inc. in Albany, New York. We have made some changes to the California method 39 in order to utilize our existing R&P 2025 particulate samplers. The R&P 2025 has been modified by replacing the 2.5 Wells impactor with a 2025 Pass Thru Adapter Tube (55-005052) thus allowing the collection of particles approximately 10 µm and smaller. The choice to use the modified R&P was based on cost considerations, availability, and existing expertise with this type of sampler.

4.7.5. Magee AE-42 Aethalometer:

VADEQ used the portable version of the Magee Aethalometer to measure the Suspended Carbonaceous Particulates by optical transmission technique.

4.7.6. NovaLynx Portable Weather Station

VADEQ used the portable weather station, NovaLynx 110-WS-18, with temperature, barometric pressure, wind speed, and wind direction capabilities to collect meteorological data. The station includes a 6 foot tripod mast and weatherproof suitcase for the rechargeable battery operated data logger. Weather data was gathered at all 3 stations.

5.0. LABORATORY ANALYSIS:

5.1. Analysis method:

VADEQ selected the Division of Consolidated Laboratory Service (DCLS) to provide analysis of the collected samples. In order to achieve optimal results, DCLS changed some procedures from the published methods. The deviations from the methods are listed in the Standard Operation Procedures (SOPs) for Laboratory Analyses.

5.2. Method Detection Limit (MDL):

The complex analyses performed for the compounds detected in this study require several steps to perform. The combined errors for each step result in a limitation to the level at which the analytical methods can reliably detect a sample. This Method Detection Limit or MDL was determined for each of the pollutants analyzed for in the Hopewell study. The MDL is determined by analyzing 7 samples and then a statistical analysis is performed on the results of the testing to determine the value. The MDL's for each pollutant are listed below.

5.2.1. MDLs for Method TO15:

			1/17/07 MDL	11/30/07 MDL				1/17/07 MDL	11/30/07 MDL
CAS #	AQS #	Pollutant Name	ug/m3	ug/m3	CAS #	AQS #	Pollutant Name	ug/m3	ug/m3
115-07-1	43205	Propylene	0.13	0.09	25-27-4	43828	Bromodichloromethane	0.29	0.11
75-71-8	43823	Dichlorodifluoromethane	0.21	0.12	79-01-6	43824	Trichloroethylene	0.27	0.21
74-87-3	43801	Chloromethane	0.16	0.12	80-62-6	43441	Methyl Methacrylate	NA	0.15
76-14-2	43208	1,2-dichloro-1,1,2,2-tetrafluoroethane	0.45	0.12	142-82-5	43232	Heptane	0.24	0.18
75-01-4	43860	Vinyl Chloride	0.24	0.1	542-75-6	43831	cis-1,3 Dichloropropene	0.4	0.21
106-99-0	43218	1,3-Butadiene	0.18	0.11	542-75-6	43830	Trans-1,3-Dichloro-1-propene	0.54	0.23
74-83-9	43819	Bromomethane	0.34	0.12	79-00-5	43820	1,1,2-Trichloroethane	0.47	0.21
75-00-3	43812	Ethyl chloride	0.21	0.1	108-88-3	45202	Toluene	0.47	0.13
107-02-8	43505	Acrolein	NA	0.16	124-48-1	43832	Dibromochloromethane	0.75	0.18
75-69-4	43811	Trichlorofluoromethane	0.3	0.12	106-93-4	43843	1,2-Dibromoethane	0.97	0.22
75-35-4	43826	1,1-Dichloroethene	0.22	0.12	127-18-4	43817	Tetrachloroethylene	0.46	0.32
75-09-2	43802	Methylene chloride	0.25	0.1	108-90-7	45801	Chlorobenzene	0.26	0.17
76-13-1	43207	1,1,2-trichloro-1,2,2-trifluoroethane	0.59	0.17	100-41-4	45203	Ethylbenzene	0.29	0.17
540-59-0	43838	trans-1,2-Dichloroethene	0.22	0.12	108-38-3	45109	m&p - Xylene	0.53	0.23
75-34-3	43813	1,1-Dichloroethane	0.27	0.09	75-25-2	43806	Bromoform	0.64	0.48

1634-04-4	43372	Methyl tert butyl ether	0.58	0.17	100-42-5	45220	Styrene	0.39	0.21
540-59-0	43839	cis-1,2-Dichloroethene	0.14	0.1	79-34-5	43818	1,1,2,2-Tetrachloroethane	0.88	0.33
100-54-3	43231	Hexane	0.25	0.08	95-47-6	45204	o - Xylene	0.29	0.19
67-66-3	43803	Chloroform	0.29	0.12	622-96-8	45213	4-Ethyltoluene	0.5	0.27
141-78-6	43209	Ethyl Acetate	0.5	0.09	108-67-8	45207	1,3,5-Trimethylbenzene	0.35	0.23
109-99-9	46401	Tetrahydrofuran	0.25	0.06	95-63-6	45208	1,2,4-Trimethylbenzene	0.75	0.25
107-06-2	43815	1,2-Dichloroethane	0.2	0.1	541-73-1	45806	1,3-Dichlorobenzene	0.85	0.26
71-55-6	43814	1,1,1-trichloroethane	0.18	0.18	106-46-7	45807	1,4-Dichlorobenzene	0.31	0.37
71-43-2	45201	Benzene	0.19	0.1	95-50-1	45805	1,2-Dichlorobenzene	0.73	0.3
56-23-5	43804	Carbon Tetrachloride	0.27	0.14	120-82-1	45810	1,2,4-Trichlorobenzene	1.03	0.63
110-87-7	43248	Cyclohexane	0.28	0.12	87-68-3	43844	Hexachloro-1,3-Butadiene	1.35	0.38
78-87-5	43829	1,2-Dichloropropane	0.24	0.23					

5.2.2. MDLs for Method TO-11A:

MDLs run Compound Name	May-June 06	July-Sept. 07	8/13/2007	3/6/2008	4/6/2008
	MDL*	MDL*	MDL**	MDL*	MDL**
	<u>ug/cart.</u>	<u>ug/cart.</u>	<u>ug/cart.</u>	<u>ug/cart.</u>	<u>ug/cart.</u>
Formaldehyde	0.012	0.027	0.015	0.01	0.023
Acetaldehyde	0.03	0.02	0.023	0.019	0.037
Acrolein ***	0.018	0.021	0.035	0.034	0.053
Acetone	0.018	0.056	0.146	0.035	0.092
Propionaldehyde	0.024	0.039	0.135	0.032	0.053
MEK	0.058	0.055	0.063	0.04	0.045
MIBK	0.068	0.081	0.056	0.062	0.076

* 7 replicated injections of calibration standard per TO-11A method used to calculate the MDL

** 7 cartridge spikes used to calculate the MDL

*** Acrolein was determined using Method TO15 as of December 2007

5.2.1. MDLs for Method IO-3A (sample weights provided in nanograms):

CAS #	AQS #	Compounds	MDL	MDL	MDL	MDL	MDL	MDL
			ng/Filter	ng/m3*	ng/Filter	ng/m3**	ng/Filter	ng/m3**
7440-41-7	82105	Beryllium	50	0.03	50	0.03	10	0.01
7440-47-3	82112	Chromium	1070	0.67	2170	1.36	1080	0.67
7439-96-5	82132	Manganese	80	0.05	330	0.2	160	0.1
7440-02-0	82136	Nickel	400	0.25	380	0.24	350	0.22
7440-38-2	82103	Arsenic	430	0.27	770	0.48	160	0.1
7440-43-9	82110	Cadmium	30	0.02	40	0.02	20	0.01
7439-92-1	82128	Lead	150	0.1	100	0.07	160	0.1
Dates used:	Start		7/21/2006		4/12/2007		5/27/2008	
	End		4/12/2007		5/27/2008		9/30/2008	

* Assuming air volume of 1600m3

6.0. DATA ASSESSMENT:

In order to calculate the worst case scenario of the data, AQM does not include the non-detected target pollutant when calculating the average concentration. This has the consequence of creating a high bias in the calculated average for the data. Other options include reporting the non-detected samples as the MDL, $\frac{1}{2}$ MDL or zero. It should also be noted that none of the data are blank corrected, which also has the potential to create a high bias in the results. The data was presumed to have a normal distribution. When looking at the distribution of the data, consideration should be given to the standard deviations and to the handling of the non-detected samples. Results of the chemical analysis in most cases showed a high degree of variability; a fact that limits DEQ's ability to use these results to definitively establish background ambient air concentrations with a reasonable degree of confidence.

6.1. Particulate Matter PM-10 Sampling:

PM-10 is particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers. These particulates can penetrate the thoracic region of the human respiratory system. In addition to health effects, it can impair atmospheric visibility and contributes to acidic dry deposition. PM-10 sampling results can be used to evaluate the overall air quality in the area.

In order to comply with the national Ambient Air Quality Standards, PM-10 concentrations must be less than the following limits:

24-hour concentration: $150 \mu\text{g}/\text{m}^3$
Based on 3-year average of annual 98th percentile values

PM-10 filter samples collected at the three sampling sites were weighed to determine gravimetric concentrations. The following are the date spans that the PM-10 samples were collected:

- November 1, 2006 through September 30, 2008 at Spruance
- November 19, 2006 through September 30, 2008 at C.G. Woodson
- February 5, 2007 through September 30, 2008 at VCU Rice Center

Gravimetric concentration results of the collected samples were submitted to the EPA database, Air Quality System (AQS). Detailed reports of these results are available upon request.

The following table is a summary statistical analysis of PM-10 data from filter samples collected at the three sampling sites (unit of concentration is $\mu\text{g}/\text{m}^3$). The measured gravimetric concentrations for PM-10 are below the allowable annual standards for PM-10 concentration.

Table 6.1.1 Sample statistics for PM10 measurements at all three sites

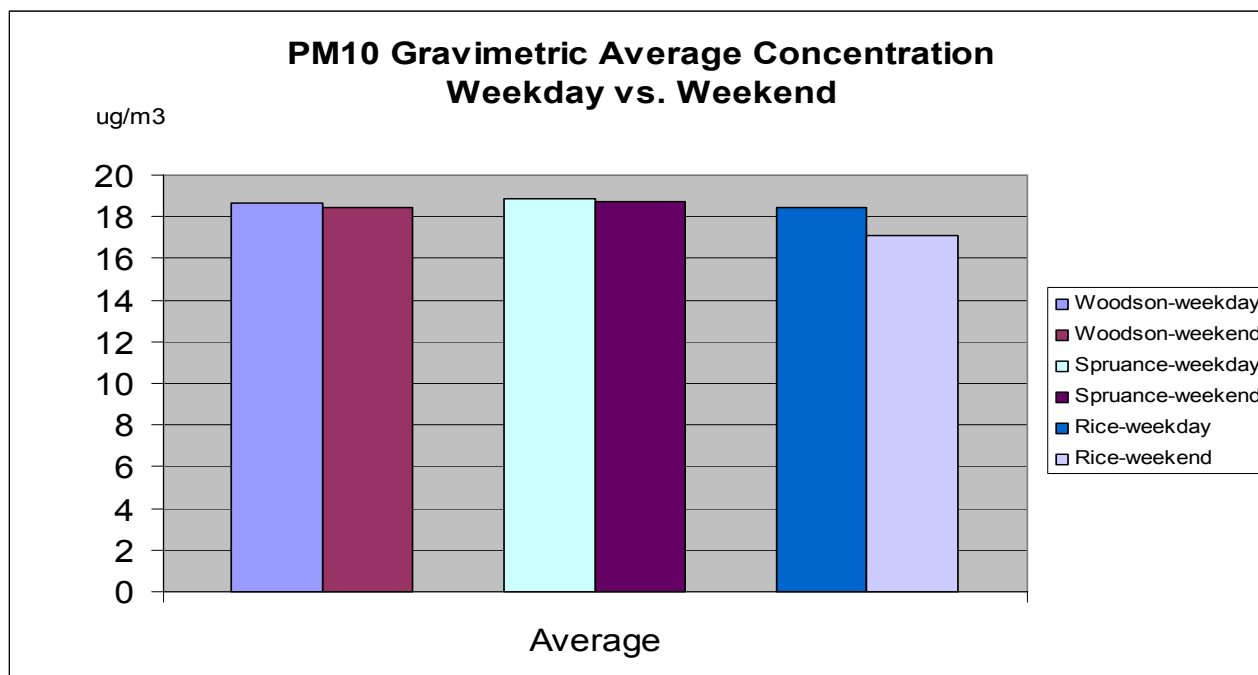
$\mu\text{g}/\text{m}^3$	Woodson	Spruance	Rice Center
No. of samples (N)	106	110	99
Minimum	4.10	6.18	2.25
Maximum	42.01	41.31	38.32
Median	17.29	17.71	17.62
Average	18.57	18.80	18.01
Standard Deviation (STD)	7.55	8.17	7.89

Average measured concentrations also were not notably different between weekday and weekend. The following table and graph demonstrate the comparison between PM10 data collected on weekdays with that collected on weekend days.

Table 6.1.2 Weekday versus Weekend PM10 results

ug/m3	Woodson		Spruance		Rice Center	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
N	74	32	78	33	69	30
Minimum	4.101	6.998	6.324	6.176	2.249	4.994
Maximum	36.249	42.006	41.309	39.464	36.459	38.315
Median	16.877	18.294	18.040	17.086	18.256	15.427
Average	18.631	18.436	18.876	18.688	18.414	17.088
STD	7.713	7.291	8.540	7.203	8.164	7.278

Chart 6.1.1 Bar Chart Comparison of Weekday versus Weekend results

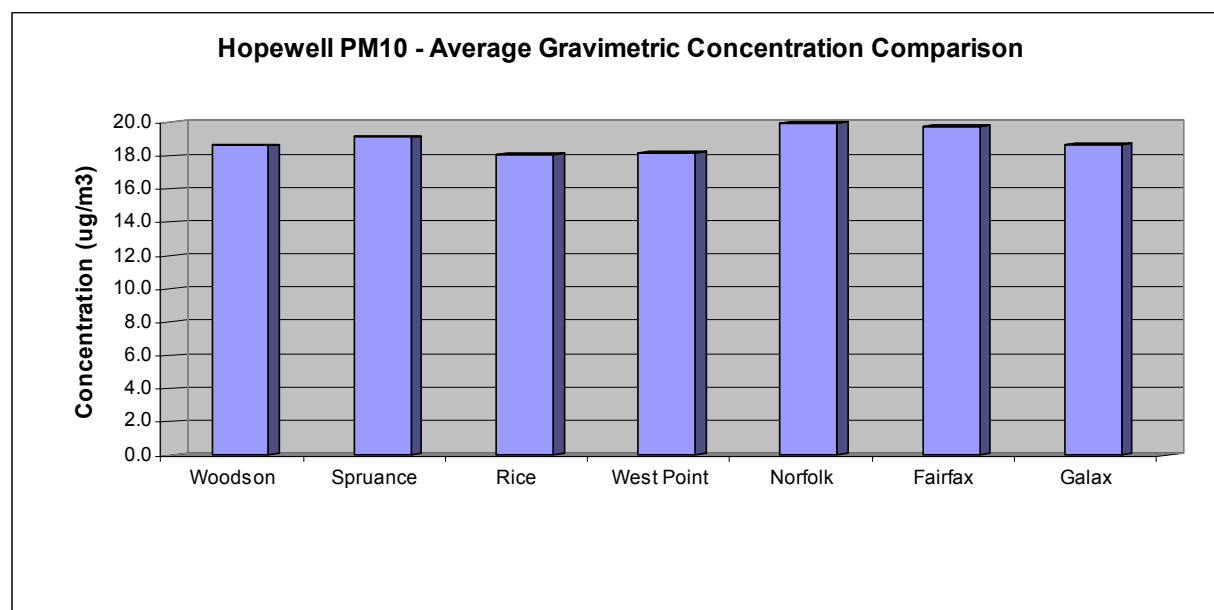


The following comparison of the PM10 2007 annual data from the three Hopewell sites and data collected at selected PM10 sampling sites in Virginia such as: West Point (rural/source orient site), Galax (rural site), Norfolk (urban site), and Fairfax (urban site) demonstrates similar results for all sites examined.

Table 6.1.3 Comparison of Hopewell to other PM10 Monitored Sites

	Hopewell sites (CY 2007)			Selected air monitoring sites (CY 2007)			
	Woodson	Spruance	Rice	West Point	Norfolk	Fairfax	Galax
N	57	56	54	58	60	53	58
Minimum	5.76	7.00	5.22	5.00	7.00	5.50	2.00
Maximum	42.01	41.31	38.32	41.00	39.00	35.00	39.00
Median	16.51	18.38	17.35	16.50	19.00	17.40	18.00
Average	18.62	19.12	18.07	18.21	19.97	19.78	18.66
STD	7.60	8.20	7.52	8.12	7.86	8.10	9.03

Chart 6.1.2 Bar Chart comparing Hopewell to other PM10 sites



6.2. PM-10 Metals Sampling:

After gravimetric measurement, the collected PM10 samples were sent to DCLS for metals analysis. DCLS used analysis method IO-3 to analyze the PM10 filters for the following metals: Arsenic (As), Beryllium (Be), Cadmium (Cd), total Chromium (Cr), Manganese (Mn), Nickel (Ni), and Lead (Pb).

6.2.1 Blank Correction

AQM ran several “blank” samples i.e. samples that were not exposed to ambient air sampling. AQM did not correct lab results for the results of the blanks even though Chromium and Nickel have a relatively high blank concentrations. Blank data for Cr and Ni should be considered when performing risk evaluations.

Table 6.2.1 Blank Concentrations for Total Chromium and Nickel

Average Blank Concentration (ng/m3)			
	Woodson	Spruance	Rice
Cr	5.49	5.38	4.78
Ni	1.46	1.26	1.19

6.2.2 Carter Woodson (upwind) site metals results

While it appears that the Woodson site has elevated average metals concentrations, this is due to some target metals having elevated concentrations in the sample collected at Woodson on March 7, 2008 i.e. Chromium (10 ng/m3), Manganese (4.6 ng/m3), Nickel (20.47 ng/m3), and Lead (6.73 ng/m3). Based on meteorological data, the primary wind direction was from the North Northeast on that date. The Woodson site on this day could be categorized as a downwind site due to wind direction. Sources of the metals could potentially be in the downtown and/or industrial area. The statistics are provided both with and without the March 7, 2008 data.

Table 6.2.2 Metals with 3/7/2008 data for Woodson (Upwind) site (nanograms/m3)

Woodson	Be	Cr	Mn	Ni	As	Cd	Pb
N	105	105	105	105	105	105	105
Min	-0.179	1.854	0.505	0.218	0.024	-0.030	0.675
Max	0.287	10.004	10.214	20.467	4.122	0.700	8.473
Median	0.022	2.820	3.054	1.148	0.925	0.178	2.766
Average	0.034	3.093	3.358	1.620	1.028	0.197	3.068
STD	0.107	1.036	1.705	2.125	0.625	0.133	1.516

Chart 6.2.1 Woodson Metals results Data Distribution Characteristics with 3/7/2008 data

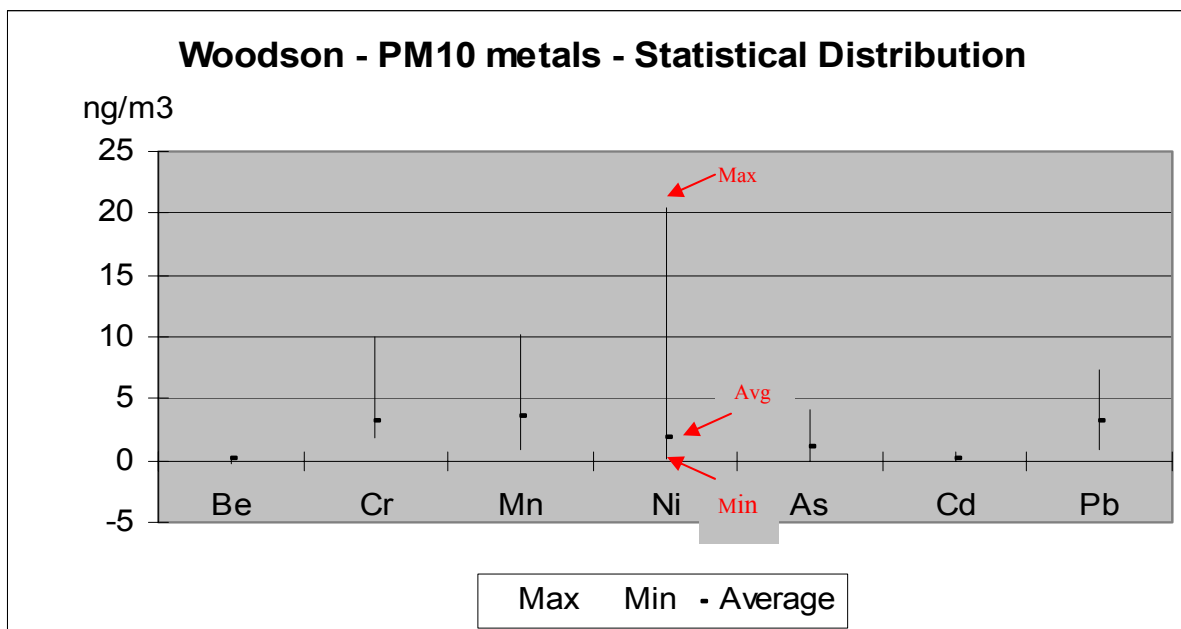
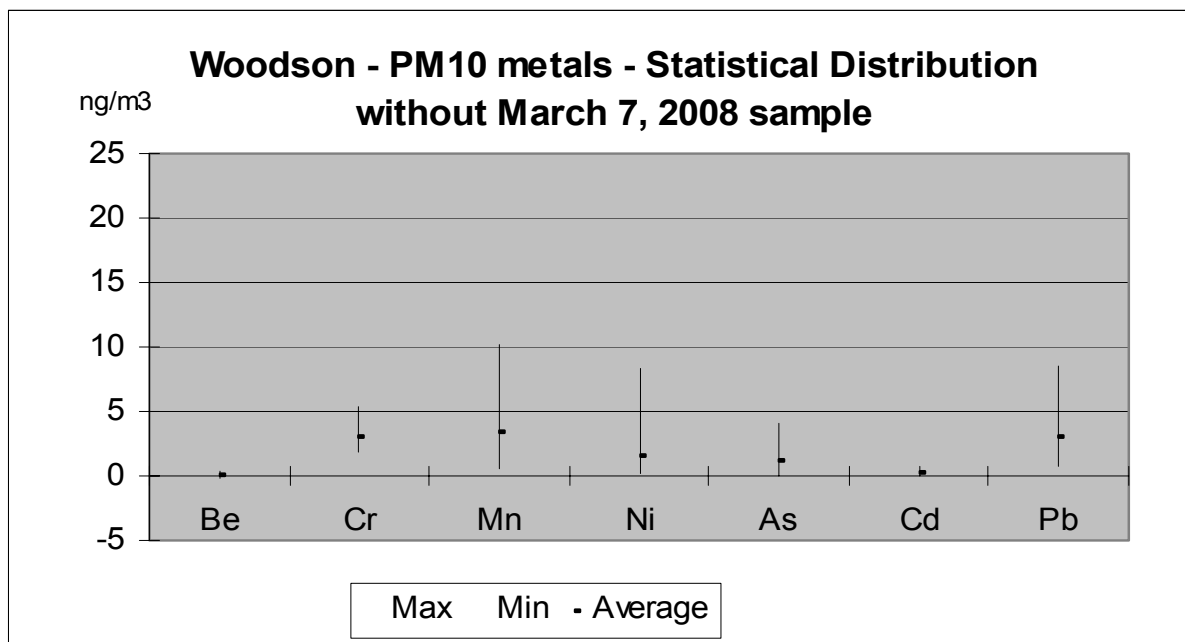


Table 6.2.3 Metals without 3/7/2008 data for Woodson (Upwind) site (nanograms/m3)

Woodson	Be	Cr	Mn	Ni	As	Cd	Pb
N	105	105	105	105	105	105	105
Min	-0.179	1.854	0.505	0.218	0.024	-0.030	0.675
Max	0.287	5.338	10.214	8.413	4.122	0.700	8.473
Median	0.022	2.820	3.054	1.148	0.925	0.178	2.766
Average	0.034	3.026	3.346	1.439	1.028	0.197	3.033
STD	0.107	1.036	1.705	2.125	0.625	0.133	1.516

Chart 6.2.2 Woodson Metals results Data Distribution Characteristics without 3/7/2008 data

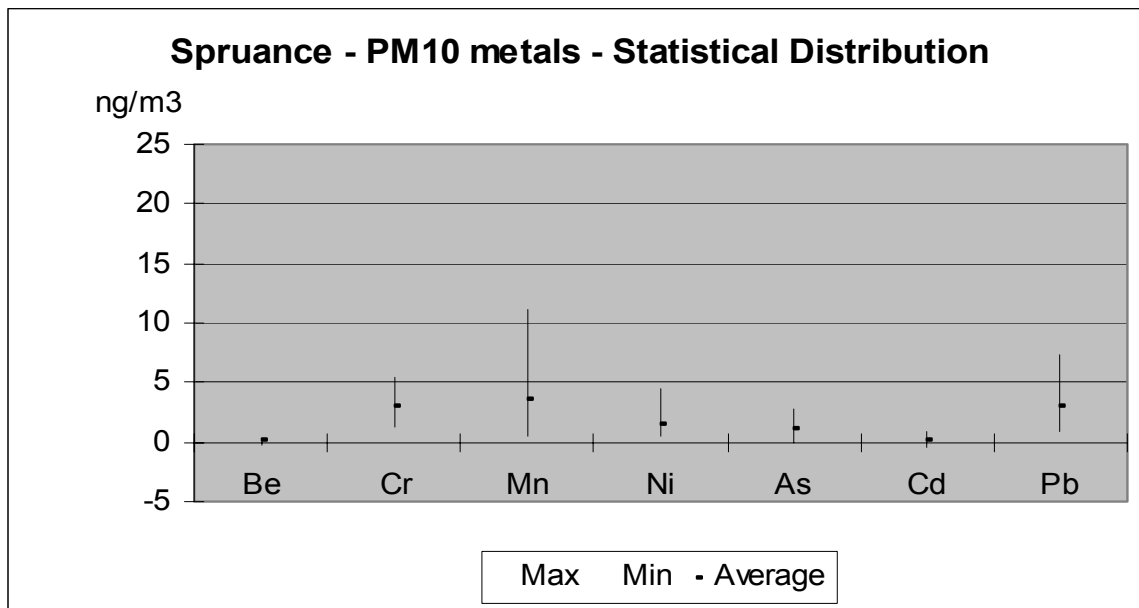


6.2.3 Spruance Street (Central) site metals results

Table 6.2.4 Metals data for Spruance (Central) site (nanograms/m3)

Spruance	Be	Cr	Mn	Ni	As	Cd	Pb
N	111	111	111	111	111	111	111
Min	-0.177	1.174	0.422	0.441	-0.106	-0.349	0.796
Max	0.284	5.429	11.159	4.466	2.742	0.972	7.273
Median	0.037	2.750	3.275	1.245	0.968	0.130	2.841
Average	0.044	2.972	3.593	1.417	1.060	0.157	2.997
STD	0.108	0.843	2.085	0.789	0.552	0.159	1.396

Chart 6.2.3 Spruance Metals results Data Distribution Characteristics

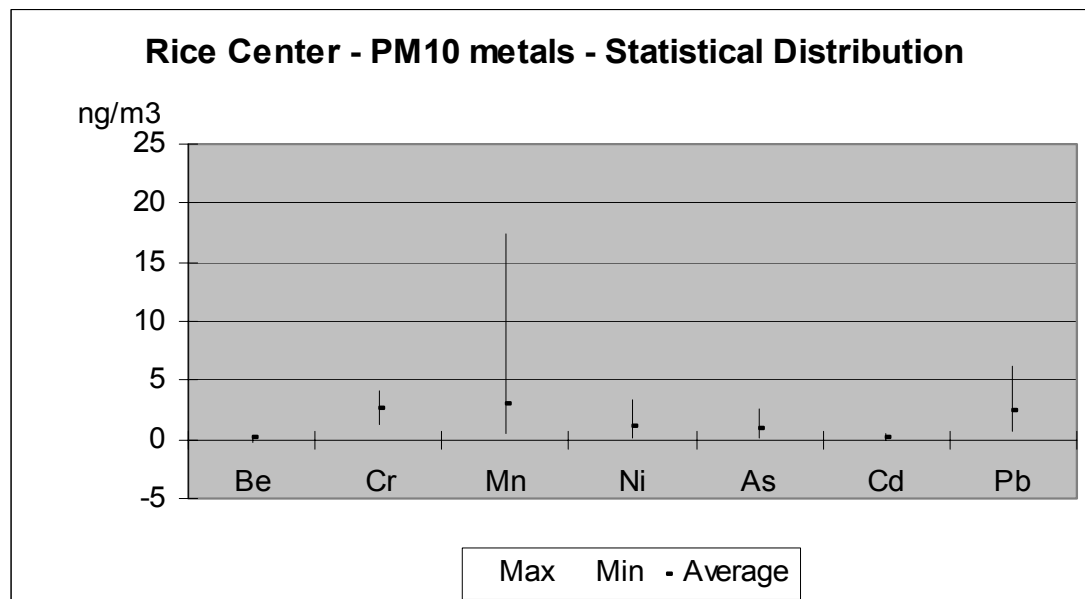


6.2.4 VCU Rice Center (downwind) site Metals results

Table 6.2.5 Metals with 9/15/2008 data for VCU Rice Center (downwind) site (nanograms/m³)

Rice	Be	Cr	Mn	Ni	As	Cd	Pb
N	99	99	99	99	99	99	99
Min	-0.24	1.18	0.56	0.18	0.11	-0.06	0.62
Max	0.28	4.10	17.37	3.37	2.55	0.45	6.17
Median	0.01	2.52	2.49	0.96	0.75	0.12	2.30
Average	0.04	2.59	3.06	1.08	0.81	0.14	2.49
STD	0.13	0.56	2.26	0.49	0.42	0.10	1.17

Chart 6.2.4 VCU Rice Center Metals results Data Distribution Characteristics



6.2.5. Metals contribution to PM10 Data

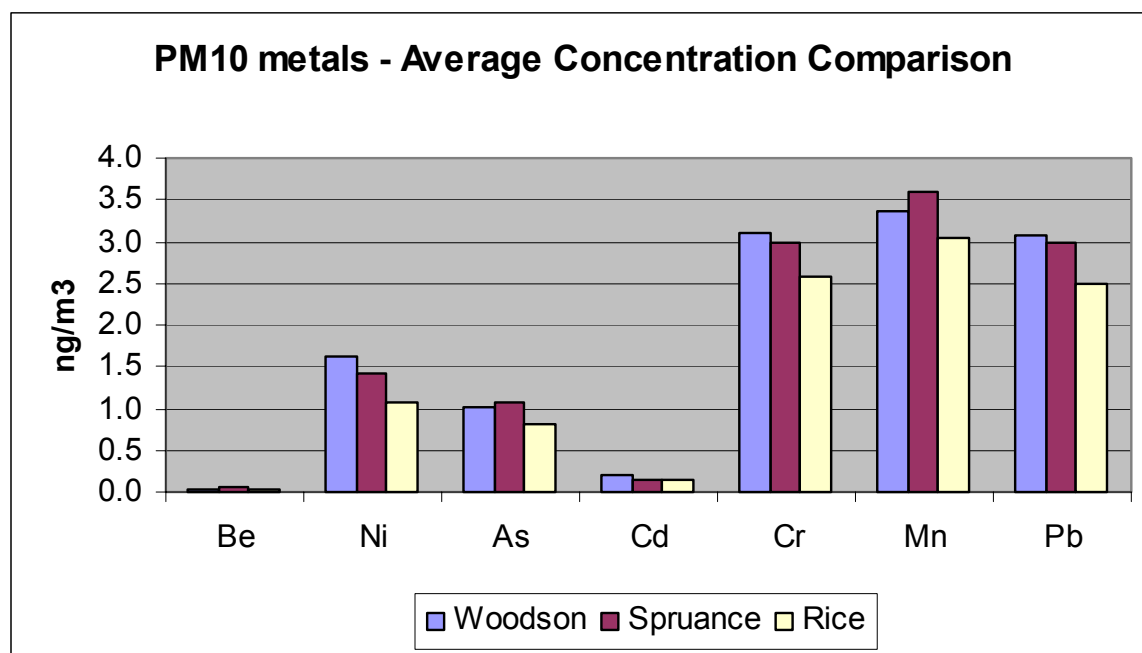
The target metals measured less than 1% of the total PM10 gravimetric weight. Chromium, Manganese and Lead had the largest contributions to the overall metal composition of the particulates collected. High concentration in Manganese and Chromium are likely due to their high concentrations in blank samples. Although Lead is one of the largest contributors to the metals fraction of the PM10, the concentration measured in Hopewell is well below the new standard promulgated in October 2008 (0.150 µg/m³).

Most target metals measured at the Rice Center were lower when compared to the other two sites. This may be due to the fact that the Rice Center is located in a remote, wooded area. The Woodson site had the highest average concentrations for Nickel, Cadmium, Chromium, and Lead of the three sites.

Table 6.2.6 Average Metals Concentrations for all sites

	Average Concentration (ng/m ³)		
	Woodson	Spruance	Rice
Be	0.034	0.044	0.043
Ni	1.620	1.417	1.081
As	1.028	1.060	0.813
Cd	0.197	0.157	0.139
Cr	3.093	2.972	2.585
Mn	3.358	3.593	3.056
Pb	3.068	2.997	2.493

Chart 6.2.5 Graphical comparison of 3 sites Metals average concentrations



6.2.6 Comparison of Metals Data – Weekday vs. Weekend

The following tables and graphs illustrate the comparison of metals measured during the week to evaluate the potential affect of traffic patterns and city activities. It suggests that most metals show higher average concentrations on the weekdays which is consistent with increased industrial and vehicular activity during the week. Arsenic and Lead show higher weekend concentrations at all three stations.

Table 6.2.7. Weekday versus Weekend data comparison - Woodson

Woodson (ng/m3)	All samples	Weekday	Weekend	Difference
Be	0.034	0.031	0.041	-32.26%
Cr	3.093	3.153	2.950	6.44%
Mn	3.358	3.531	2.944	16.62%
Ni	1.620	1.726	1.365	20.92%
As	1.028	0.969	1.169	-20.64%
Cd	0.197	0.205	0.179	12.68%
Pb	3.068	2.997	3.236	-7.97%

Chart 6.2.6 Graphical presentation of Weekday vs. Weekend comparison - Woodson

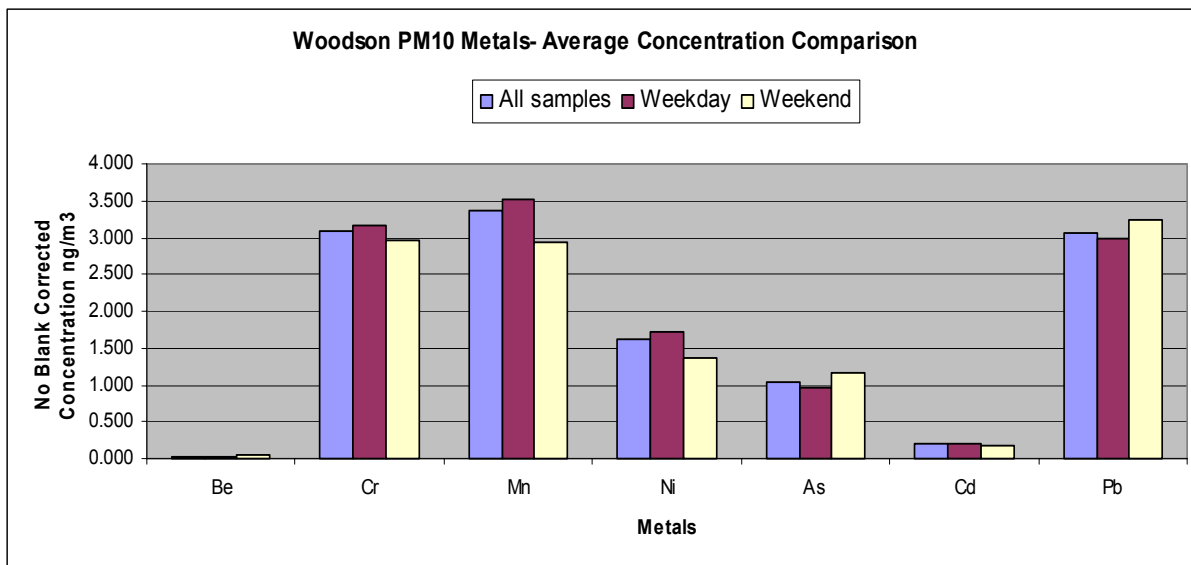


Table 6.2.8 Weekday versus Weekend data comparison - Spruance

Spruance (ng/m3)	All samples	Weekday	Weekend	Difference
Be	0.044	0.050	0.031	38.00%
Cr	2.972	3.046	2.797	8.17%
Mn	3.593	3.737	3.251	13.01%
Ni	1.417	1.513	1.191	21.28%
As	1.060	0.985	1.238	-25.69%
Cd	0.157	0.163	0.141	13.50%
Pb	2.997	2.900	3.226	-11.24%

Chart 6.2.7 Graphical presentation of Weekday vs. Weekend comparison - Spruance

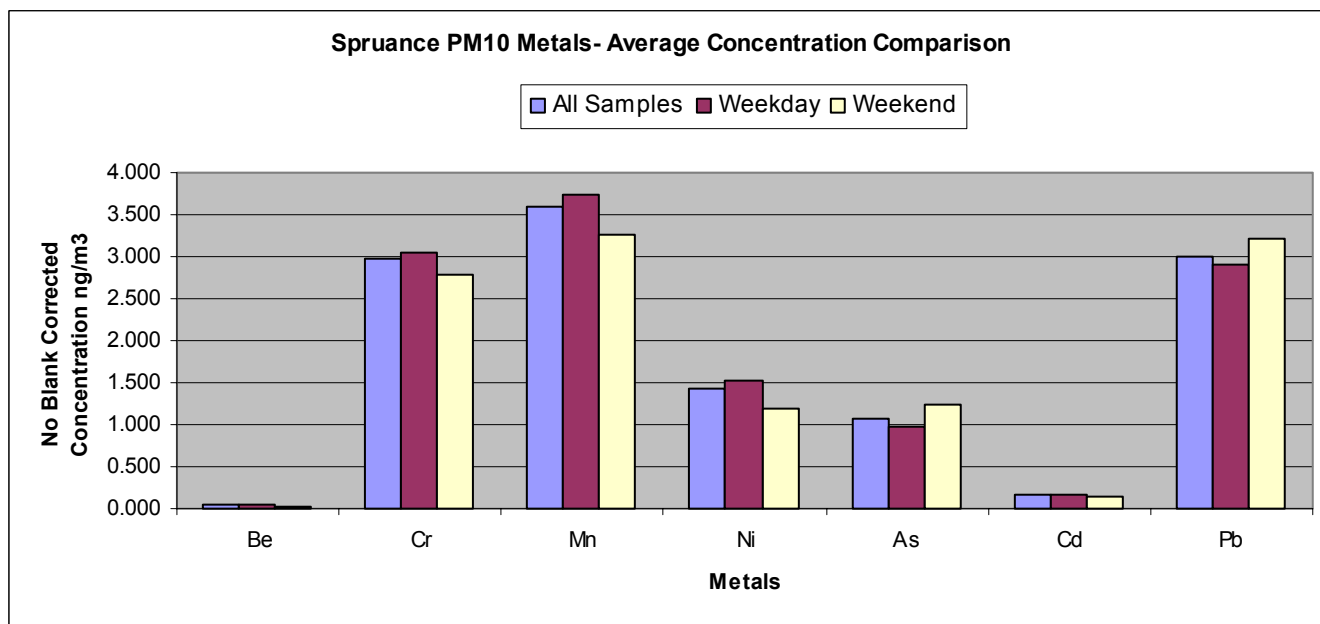
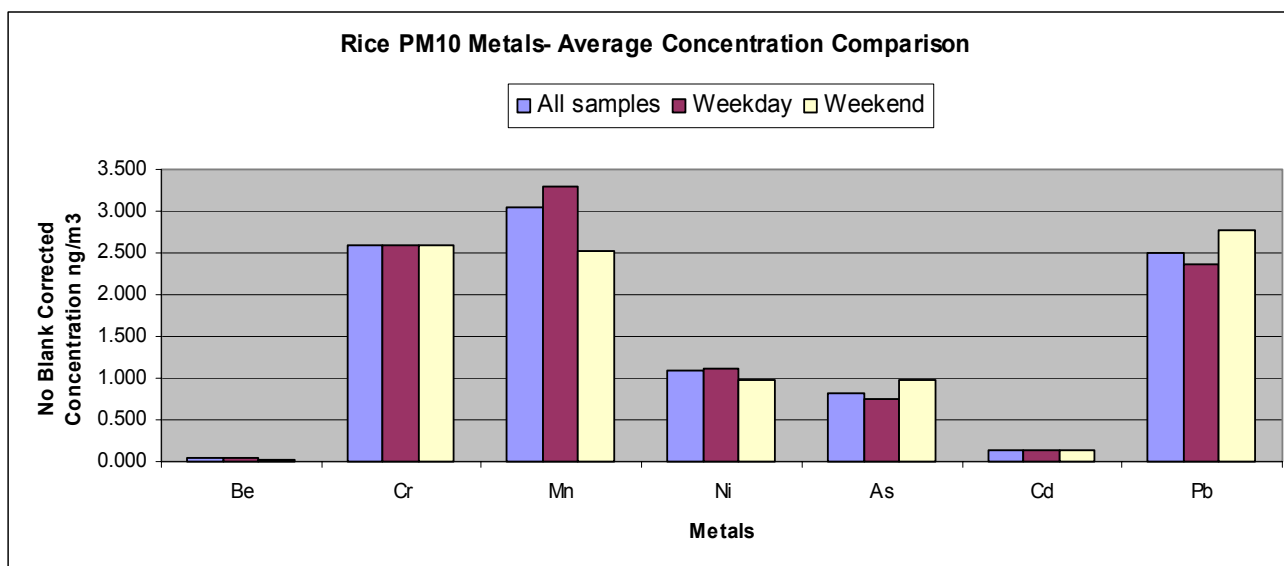


Table 6.2.9 Weekday versus Weekend data comparison – VCU Rice Center

Rice (ng/m3)	All samples	Weekday	Weekend	Difference
Be	0.043	0.054	0.017	68.52%
Cr	2.585	2.583	2.591	-0.31%
Mn	3.056	3.287	2.525	23.18%
Ni	1.081	1.122	0.987	12.03%
As	0.813	0.745	0.969	-30.07%
Cd	0.139	0.142	0.132	7.04%
Pb	2.493	2.370	2.778	-17.22%

Chart 6.2.8 Graphical presentation of Weekday vs. Weekend comparison – VCU Rice Center



6.3. Carbonyl Sampling:

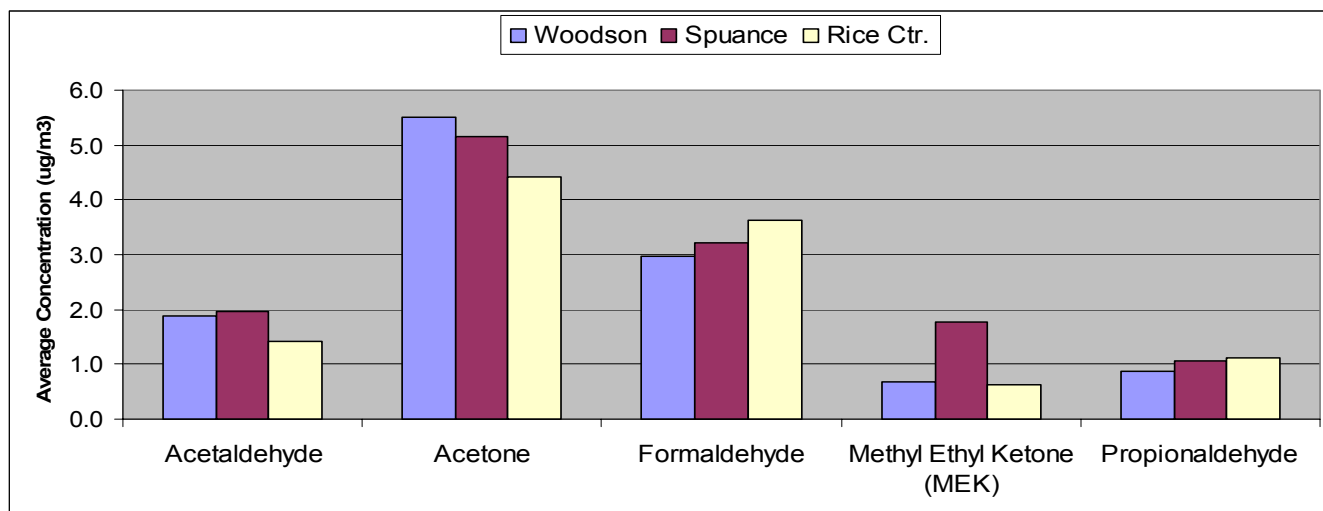
Some low molecular weight aldehydes and ketones affect humans and animals primarily as an irritant, affecting mucous membranes of the eyes, upper respiratory tract, and the skin. Sources of carbonyl compounds into the atmosphere range from natural occurrences to secondary formation through atmospheric photochemical reactions. (i.e. Acetaldehyde is found in apples and as a by-product of alcoholic fermentation). Carbonyl compounds in the atmosphere may also be attributed to motor vehicle emissions. (i.e. formaldehyde is the major carbonyl in automobile exhaust). As secondary formation through atmospheric photochemical reactions, carbonyls can be formed from motor vehicles that emit reactive hydrocarbons that undergo photochemical oxidation.

The Division of Consolidated Laboratory Services (DCLS) analyzed the collected samples, from each of the three sites, for seven (7) carbonyl compounds: Acetone, Acetaldehyde, Formaldehyde, Acrolein, MEK, MIBK, and Propionaldehyde. Among the target carbonyls, Acetone and MEK are not included in the list of 188 Hazardous Air Pollutants (HAPs). MIBK was not detected in all collected samples because its concentration was lower than the Method Detection Limit (MDL). The absence of Acrolein in the collected samples was later determined to be a limitation in the selected TO-11A analysis method. Beginning in December of 2007 Acrolein was analyzed using Method TO-15 from the canister samples taken for the VOC constituents.

Table 6.3.1 Carbonyl Results for 3 Hopewell Sites

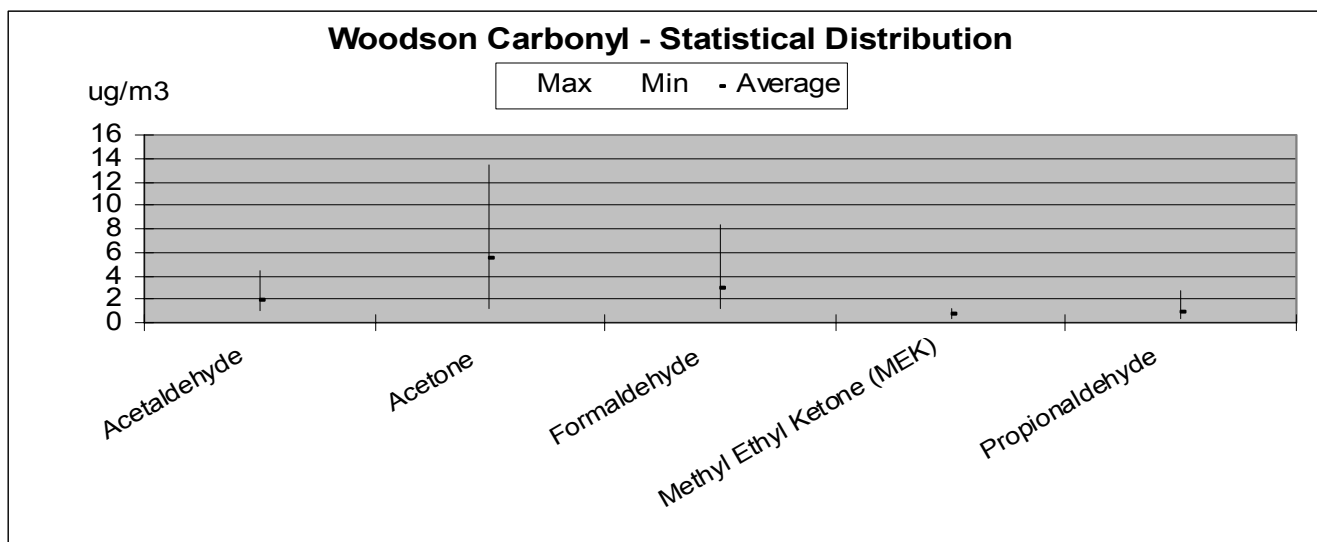
ug/m3	Acetaldehyde			Acetone			Formaldehyde			Methyl Ethyl Ketone (MEK)			Propionaldehyde		
	Woodson	Spruance	Rice	Woodson	Spruance	Rice	Woodson	Spruance	Rice	Woodson	Spruance	Rice	Woodson	Spruance	Rice
N	109	109	95	107	109	88	111	110	95	91	89	70	45	47	26
Min	0.95	0.93	0.62	1.15	0.76	0.92	1.11	1.11	0.99	0.35	0.20	0.31	0.31	0.23	0.40
Max	4.36	5.28	2.75	13.40	11.22	10.07	8.35	8.63	10.69	1.21	74.45	1.03	2.74	2.81	2.55
Median	1.70	1.81	1.41	4.66	4.26	4.10	2.45	2.59	2.98	0.68	0.80	0.59	0.70	0.98	0.82
Average	1.87	1.96	1.41	5.52	5.14	4.42	2.96	3.22	3.62	0.69	1.76	0.62	0.88	1.06	1.12
STD	0.71	0.80	0.43	2.52	2.41	1.72	1.55	1.79	2.23	0.19	7.81	0.17	0.55	0.69	0.73

Chart 6.3.1 Graphical results of Carbonyl Analysis for 3 Hopewell Sites



Excluding Acrolein and Methyl Isobutyl Ketone (MIBK), DCLS found five targeted pollutants in almost every sample. One unexpected result of the analysis was finding higher average concentrations of Formaldehyde and Propionaldehyde at the Rice Center site compared to the other sites. These higher formaldehyde concentrations appear to coincide with a construction project that began on the Rice Center site in late 2007. The following charts summarize the statistical distribution of the collected carbonyls data which include minimum, average, and maximum concentrations measured by DCLS:

Chart 6.3.2 Woodson Carbonyl results Data Distribution Characteristics



There was an unusually high concentration of Methyl Ethyl Ketone (MEK) on Saturday, October 27, 2007 at the Spruance site. Based on the meteorological data, the primary wind direction on October 27 was from the West Northwest.

Chart 6.3.3 Spruance Carbonyl results Data Distribution Characteristics

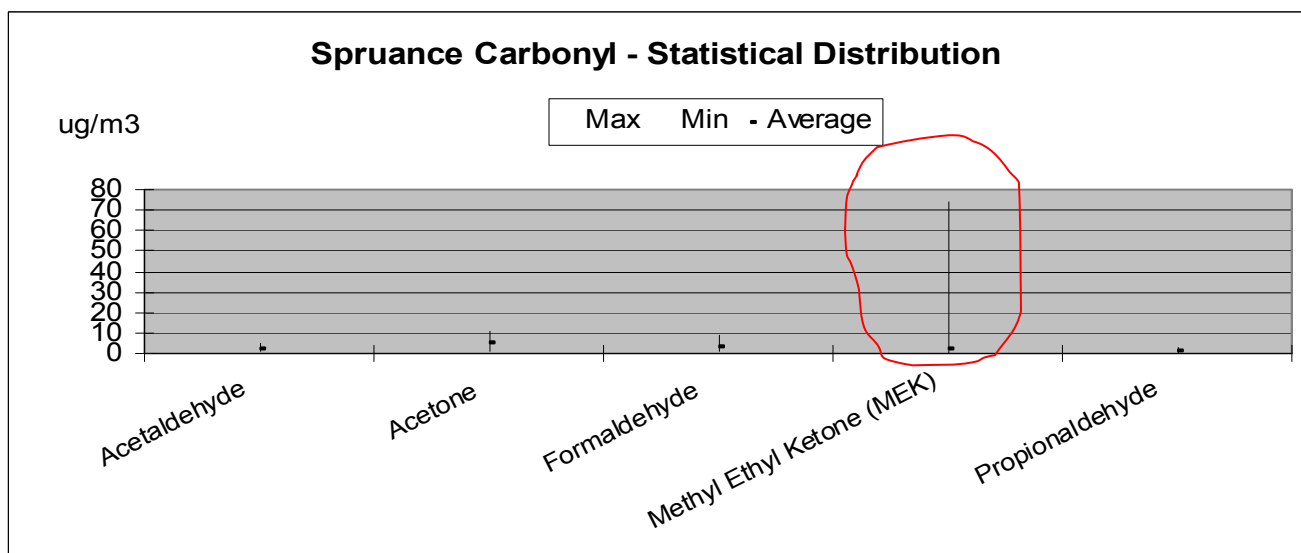
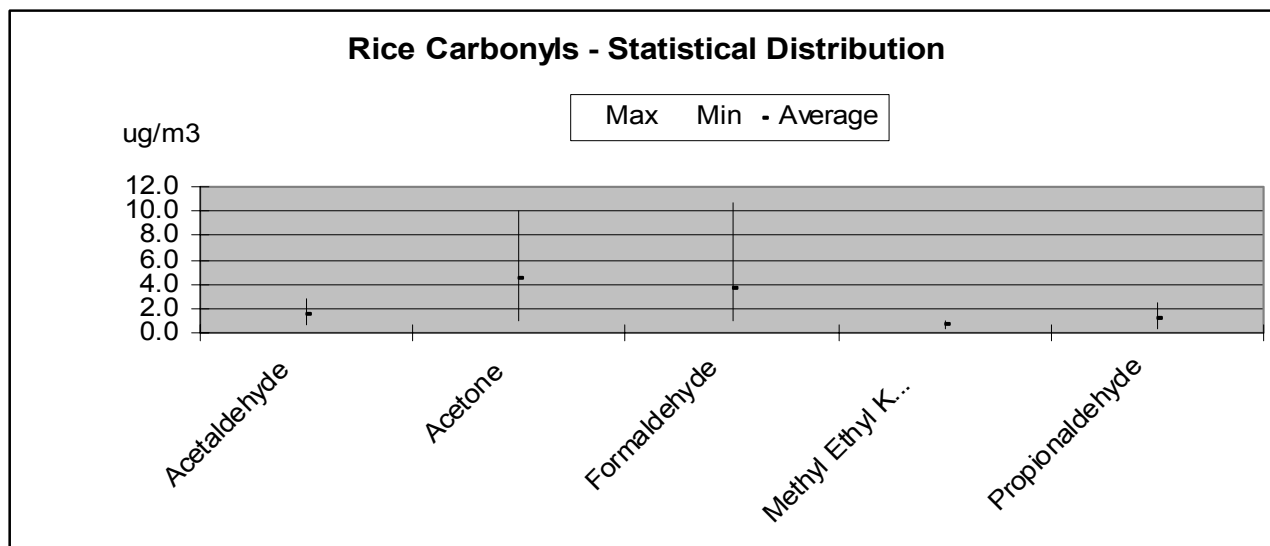


Chart 6.3.4 VCU Rice Center results Data Distribution Characteristics



6.3.1 Comparison of Hopewell Carbonyl results with VA Urban Toxics Sites

The following tables compare the average concentrations of the five abundant Carbonyl compounds found in Hopewell with three existing Urban Air Toxic sampling sites in Virginia:

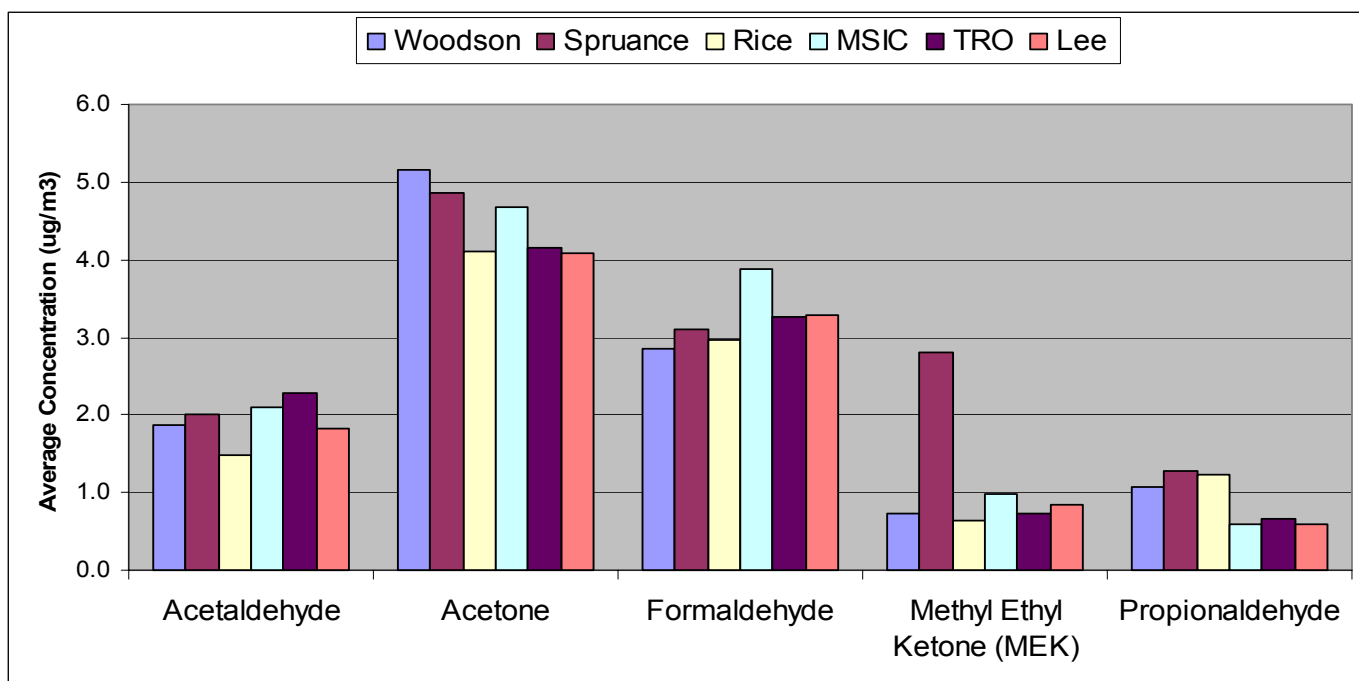
- MSIC: MathScience Innovation Center in Richmond
- TRO: Tidewater DEQ Regional Office in Virginia Beach
- Lee: Lee District Park in Fairfax

Table 6.3.3 Hopewell and Urban sites Toxics information

Unit of Concentration: ug/m3	Woodson	Spruance	Rice	MSIC	TRO	Lee
Acetaldehyde	1.88	2.00	1.47	2.11	2.29	1.84
Acetone	5.16	4.87	4.11	4.67	4.15	4.08
Formaldehyde	2.86	3.10	2.96	3.88	3.26	3.29
Methyl Ethyl Ketone (MEK)	0.73	2.81	0.64	0.97	0.74	0.85
Propionaldehyde	1.08	1.28	1.23	0.59	0.66	0.59

The data provided for the urban toxics sites are drawn from the Annual Monitoring Report published each year by the Office of Air Quality Monitoring. The data for this report is handled differently than the data in the Hopewell analysis. The Hopewell data uses only detectable information where as the urban sites information, because they have different reporting rules applied by EPA, includes zeros for the non-detectable information and actual analytical information for some results below the method detection level. This difference is unlikely to have a large impact on the data due to the low number of non-detect samples in the carbonyl analysis.

Chart 6.3.5 Graphical Presentation of Hopewell and Urban Toxics Data Comparison



Carbonyl compounds monitored in Hopewell have similar concentration levels with those measured at Lee District Park (Fairfax County), MathScience Innovation Center (Richmond City), and the Tidewater Regional Office (Virginia Beach) with the exception of Spruance's average concentration of MEK. However, without the spike detected on 10/27/2007, the average concentration of MEK at Spruance would be 0.93 ug/m3.

6.3.2 Comparison of Carbonyls Data – Weekday vs. Weekend

The following table illustrates the comparison of target carbonyls measured during the week to those measured on the weekend in order to evaluate the affect of traffic patterns and city activities. The average concentration of the detected carbonyls during the weekdays was similar to those during the weekend except MEK measured at the Spruance site. The comparison suggested that traffic and daily activities are not the major factors for the target carbonyls emission in the area

Table 6.3.4 Weekday versus Weekend data comparison – 3 Hopewell Sites

ug/m3	Woodson				Spruance				Rice			
	All Samples	Weekday	Weekend	Difference (%)	All Samples	Weekday	Weekend	Difference (%)	All Samples	Weekday	Weekend	Difference (%)
Acetaldehyde	1.87	1.85	1.93	-4.32	1.96	1.94	2.01	-3.61	1.41	1.46	1.39	4.79
Acetone	5.52	5.46	5.65	-3.48	5.14	5.31	4.74	10.73	4.42	4.52	4.07	9.96
Formaldehyde	2.96	2.99	2.88	3.68	3.22	3.25	3.14	3.38	3.62	3.67	3.49	4.90
Methyl Ethyl Ketone (MEK)	0.69	0.71	0.67	5.63	1.76	1.01	3.92*	288.12	0.62	0.63	0.58	7.94
Propionaldehyde	0.88	0.89	0.84	5.62	1.06	1.02	1.12	-9.80	1.12	1.15	1.04	9.57

* Data includes October 27, 2007 spike at the Spruance site

Chart 6.3.6 Graphical presentation of Weekday vs. Weekend comparison – Woodson Site

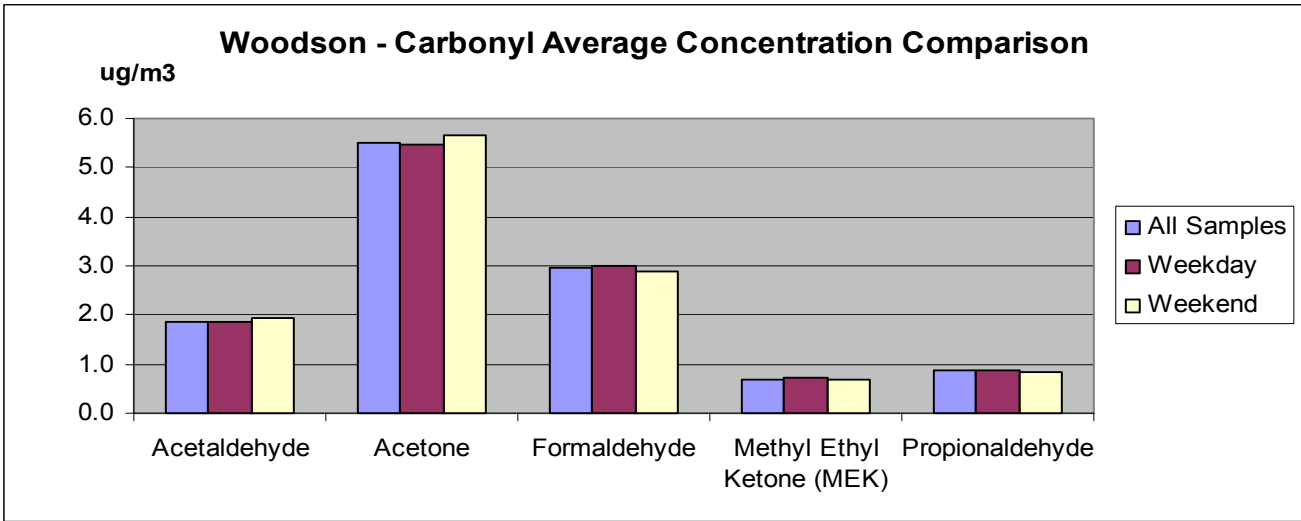


Chart 6.3.6 Graphical presentation of Weekday vs. Weekend comparison – Spruance Site

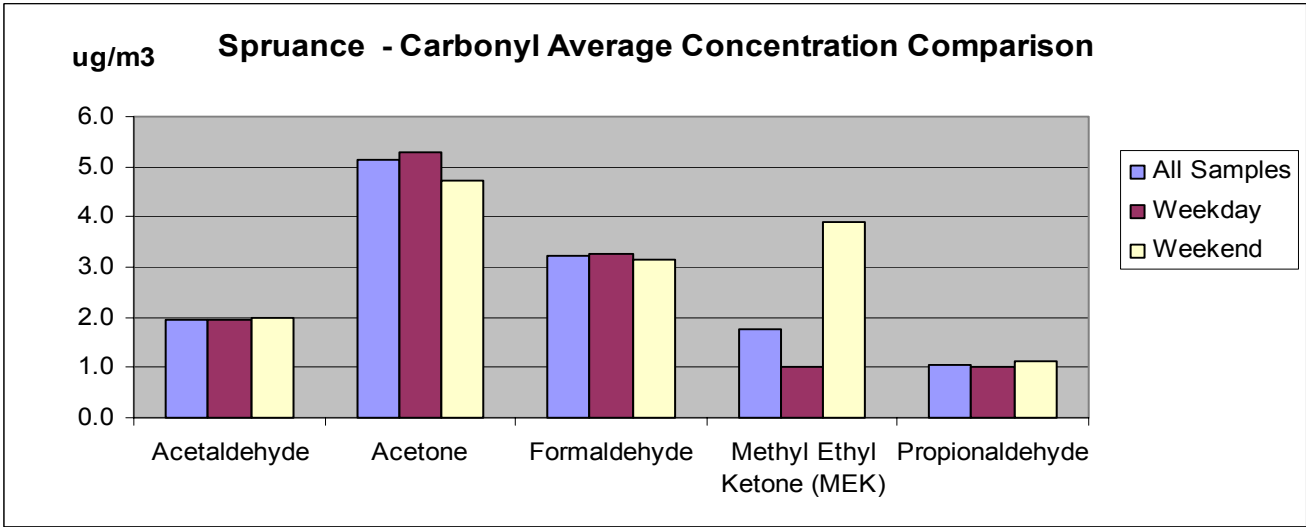
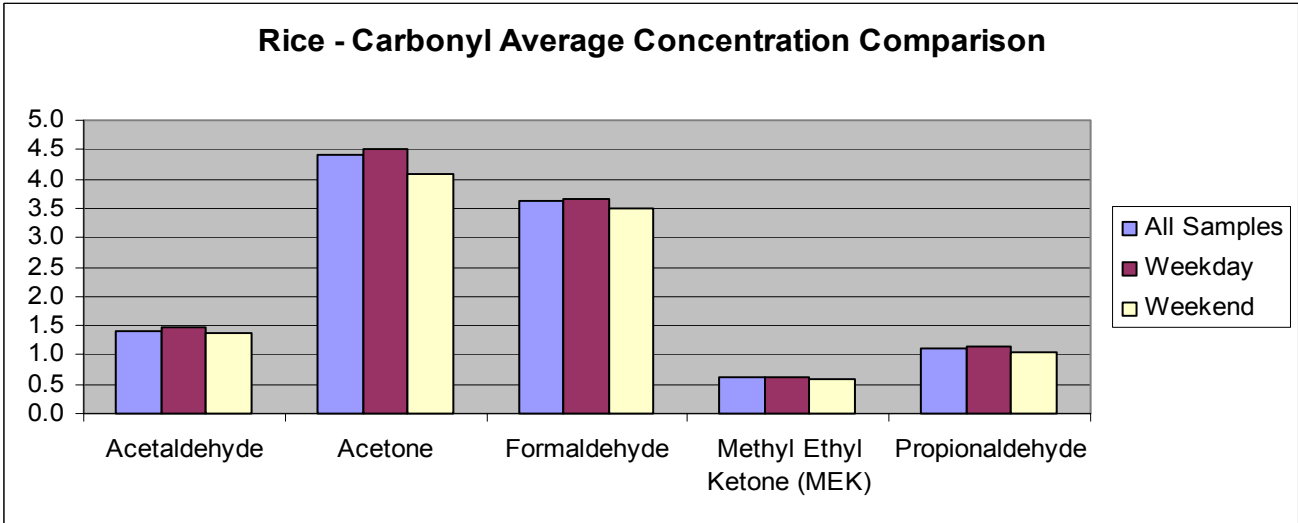


Chart 6.3.6 Graphical presentation of Weekday vs. Weekend comparison – VCU Rice Center



6.4. Volatile Organic Compounds Sampling:

There are 35 published Hazardous Air Pollutant (HAPs) in the list of the project's 53 Target Volatile Organic Compounds (VOC). These HAPs are known or suspected to cause human health impacts and/or adverse environmental effects. The analysis that follows does not include the non-detectable samples in the calculations similar to the previous analyses. The list of targeted pollutants is provided in Table 4.4.1 above.

6.4.1 C.G. Woodson (Upwind) Site:

DCLS used the EPA TO-15 method to analyze the 109 collected canister samples at the C.G. Woodson site from November 29, 2006 to September 27, 2008. There were five voided samples because of power issues and other problems. Only 24 target compounds, which had concentrations above the method Detection Limit (MDL), were detected. Among those compounds, there were 15 frequently detected pollutants with a detection rate $\geq 10\%$.

Table 6.4.1 Detection Rates of VOC's at the Woodson Site

Target Pollutants	Detection Rate	Target Pollutants	Detection Rate
Methyl Chloride	99.08%	Acrolein	55.77%
Freon-12	97.25%	m&p-Xylene	46.79%
Freon-11	95.41%	1,2,4-Trimethylbenzene	30.28%
Toluene	89.91%	Hexane	20.18%
Freon-113	72.48%	o-Xylene	16.51%
Benzene	71.56%	Heptane	14.68%
Carbon Tetrachloride	68.81%	Ethylbenzene	14.68%
Methylene Chloride	62.39%		

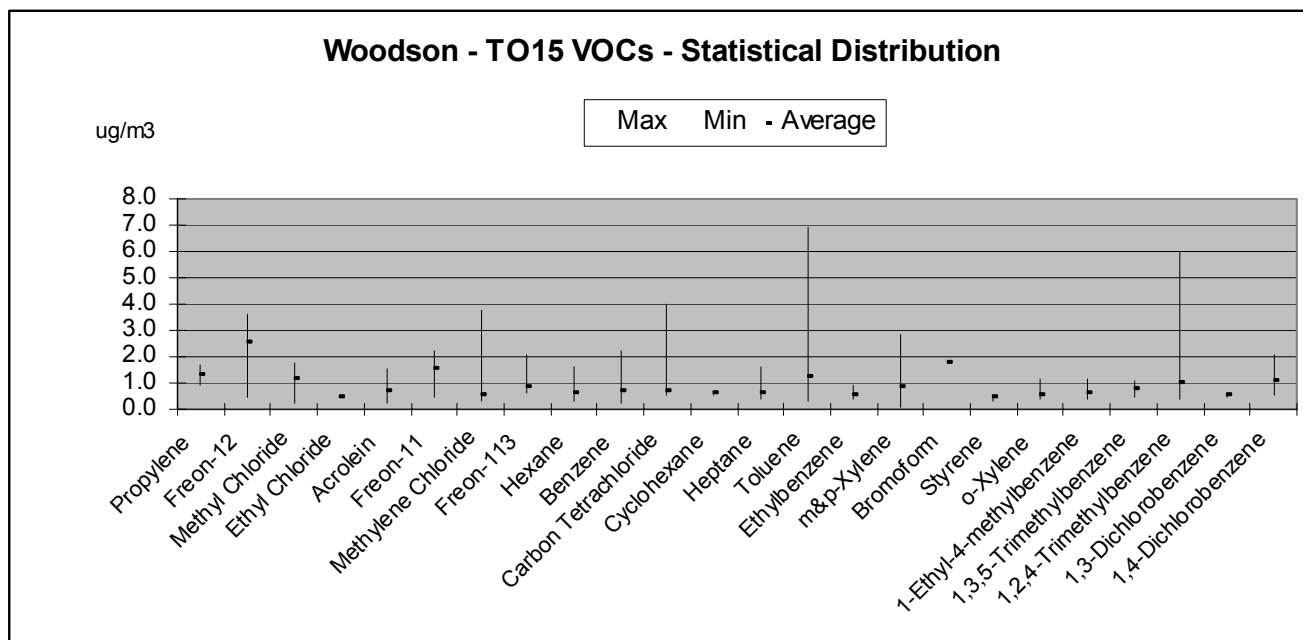
Table 6.4.2 below lists the statistics for the data results from the samples at the Woodson Site. Acrolein information is provided in this table but was only analyzed with the VOC results beginning in December 2007. This is due to a change in the methodology used to analyze for Acrolein. The acrolein data listed below does not have one full year's worth of data for comparison. The results listed below are provided in $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter).

Table 6.4.2 Woodson (upwind) Site VOC results

#	CAS #	Pollutants ($\mu\text{g}/\text{m}^3$)	N	Minimum	Maximum	Median	Average	STD
1	115-07-1	Propylene	2	0.945	1.668	1.307	1.307	0.511
2	75-71-8	Freon-12	106	0.494	3.606	2.569	2.525	0.525
3	74-87-3	Methyl Chloride	108	0.206	1.753	1.134	1.146	0.281
4	75-00-3	Ethyl Chloride	1	0.474	0.474	0.474	0.474	
5	107-02-8	Acrolein	29	0.252	1.557	0.710	0.721	0.360
6	75-69-4	Freon-11	104	0.449	2.245	1.515	1.528	0.296
7	75-09-2	Methylene Chloride	68	0.277	3.781	0.416	0.565	0.490
8	76-13-1	Freon-113	79	0.612	2.067	0.765	0.857	0.257
9	100-54-3	Hexane	22	0.282	1.584	0.528	0.640	0.354
10	71-43-2	Benzene	78	0.255	2.266	0.558	0.667	0.364
11	56-23-5	Carbon Tetrachloride	75	0.503	4.022	0.628	0.704	0.401
12	110-87-7	Cyclohexane	2	0.550	0.653	0.602	0.602	0.073
13	142-82-5	Heptane	16	0.368	1.638	0.512	0.604	0.300
14	108-88-3	Toluene	98	0.339	6.888	0.885	1.244	0.977
15	100-41-4	Ethylbenzene	16	0.347	0.954	0.477	0.550	0.192

16	108-38-3	m&p-Xylene	51	0.056	2.863	0.564	0.835	0.618
17	75-25-2	Bromoform	1	1.755	1.755	1.755	1.755	
18	100-42-5	Styrene	3	0.340	0.553	0.468	0.454	0.107
19	95-47-6	o-Xylene	18	0.347	1.171	0.477	0.566	0.233
20	622-96-8	1-Ethyl-4-methylbenzene	4	0.393	1.129	0.466	0.614	0.346
21	108-67-8	1,3,5-Trimethylbenzene	4	0.442	1.080	0.712	0.737	0.343
22	95-63-6	1,2,4-Trimethylbenzene	33	0.393	5.991	0.638	1.003	1.021
23	541-73-1	1,3-Dichlorobenzene	4	0.480	0.601	0.540	0.540	0.069
24	106-46-7	1,4-Dichlorobenzene	8	0.540	2.042	0.901	1.066	0.548

Chart 6.4.1 Woodson VOC results Data Distribution Characteristics



6.4.2. Spruance Road (Central) Site:

DCLS used the EPA TO-15 method to analyze 115 collected canister samples from November 1, 2006 to September 27, 2008 at the Spruance site, the project's central site. Only 27 target compounds, which had concentrations above the method Detection Limit (MDL), were detected from the collected samples. Among the detected compounds, there were 16 frequently detected pollutants with a detection rate $\geq 10\%$.

Table 6.4.3 Detection Rates of VOC's at the Spruance Site

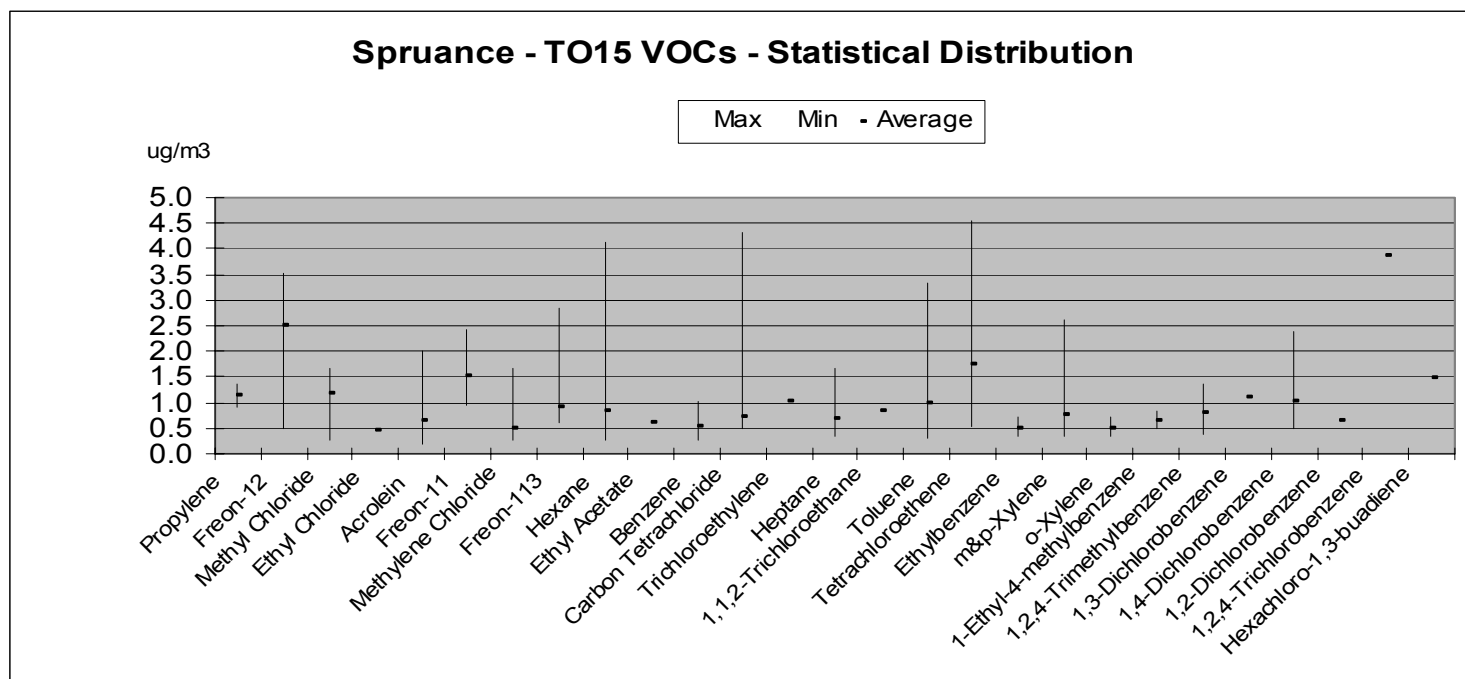
Pollutants	Detection Rate	Pollutants	Detection Rate
Methyl Chloride	100.00%	Methylene Chloride	54.78%
Freon-12	98.26%	m&p-Xylene	42.61%
Freon-11	94.78%	Hexane	25.22%
Toluene	94.78%	1,2,4-Trimethylbenzene	24.35%
Benzene	78.26%	o-Xylene	13.91%
Freon-113	75.65%	Heptane	11.30%
Carbon Tetrachloride	72.17%	Ethylbenzene	11.30%
Acrolein	61.54%	1,4-Dichlorobenzene	11.30%

Table 6.4.4 below lists the statistics for the data results from the samples at the Spruance Site. Acrolein information is provided in this table but was only analyzed with the VOC results beginning in December 2007. This is due to a change in the methodology used to analyze for Acrolein. The acrolein data listed below does not have one full year's worth of data for comparison. The results listed below are provided in $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter).

Table 6.4.4 Spruance (central) Site VOC results

#	CAS #	Pollutants ($\mu\text{g}/\text{m}^3$)	N	Minimum	Maximum	Median	Average	STD
1	115-07-1	Propylene	2	0.911	1.358	1.135	1.135	0.316
2	75-71-8	Freon-12	113	0.494	3.507	2.470	2.484	0.514
3	74-87-3	Methyl Chloride	115	0.248	1.650	1.176	1.160	0.263
4	75-00-3	Ethyl Chloride	1	0.448	0.448	0.448	0.448	
5	107-02-8	Acrolein	32	0.183	2.015	0.618	0.653	0.368
6	75-69-4	Freon-11	109	0.954	2.413	1.515	1.520	0.260
7	75-09-2	Methylene Chloride	63	0.277	1.665	0.416	0.495	0.251
8	76-13-1	Freon-113	87	0.612	2.832	0.842	0.911	0.381
9	100-54-3	Hexane	29	0.282	4.119	0.739	0.832	0.709
10	141-78-6	Ethyl Acetate	1	0.612	0.612	0.612	0.612	
11	71-43-2	Benzene	90	0.255	1.021	0.511	0.541	0.207
12	56-23-5	Carbon Tetrachloride	83	0.503	4.336	0.628	0.712	0.452
13	79-01-6	Trichloroethylene	1	1.020	1.020	1.020	1.020	
14	142-82-5	Heptane	13	0.328	1.678	0.614	0.699	0.394
15	79-00-5	1,1,2-Trichloroethane	1	0.818	0.818	0.818	0.818	
16	108-88-3	Toluene	109	0.301	3.350	0.790	0.985	0.642
17	127-18-4	Tetrachloroethene	6	0.542	4.539	1.253	1.739	1.495
18	100-41-4	Ethylbenzene	13	0.347	0.737	0.434	0.477	0.124
19	108-38-3	m&p-Xylene	49	0.347	2.603	0.651	0.747	0.421
20	95-47-6	o-Xylene	16	0.347	0.737	0.499	0.493	0.132
21	622-96-8	1-Ethyl-4-methylbenzene	2	0.491	0.835	0.663	0.663	0.243
22	95-63-6	1,2,4-Trimethylbenzene	28	0.393	1.375	0.712	0.786	0.309
23	541-73-1	1,3-Dichlorobenzene	1	1.081	1.081	1.081	1.081	
24	106-46-7	1,4-Dichlorobenzene	13	0.480	2.402	0.901	1.007	0.563
25	95-50-1	1,2-Dichlorobenzene	1	0.661	0.661	0.661	0.661	
26	120-82-1	1,2,4-Trichlorobenzene	1	3.855	3.855	3.855	3.855	
27	87-68-3	Hexachloro-1,3-butadiene	1	1.491	1.491	1.491	1.491	

Chart 6.4.2 Spruance Site VOC results Data Distribution Characteristics



6.4.3 VCU Rice Center (Downwind) Site:

DCLS used the EPA TO-15 method to analyze 94 collected canister samples at the VCU Rice Center site, the project's downwind site. There were 7 voided samples because of various reasons (i.e. power outage). Only 15 targeted compounds, which had concentrations above the method Detection Limit (MDL), were detected from the collected samples. Among the detected compounds, there were 9 frequently detected pollutants with a detection rate $\geq 10\%$.

Table 6.4.5 Detection Rates of VOC's at the VCU Rice Center Site

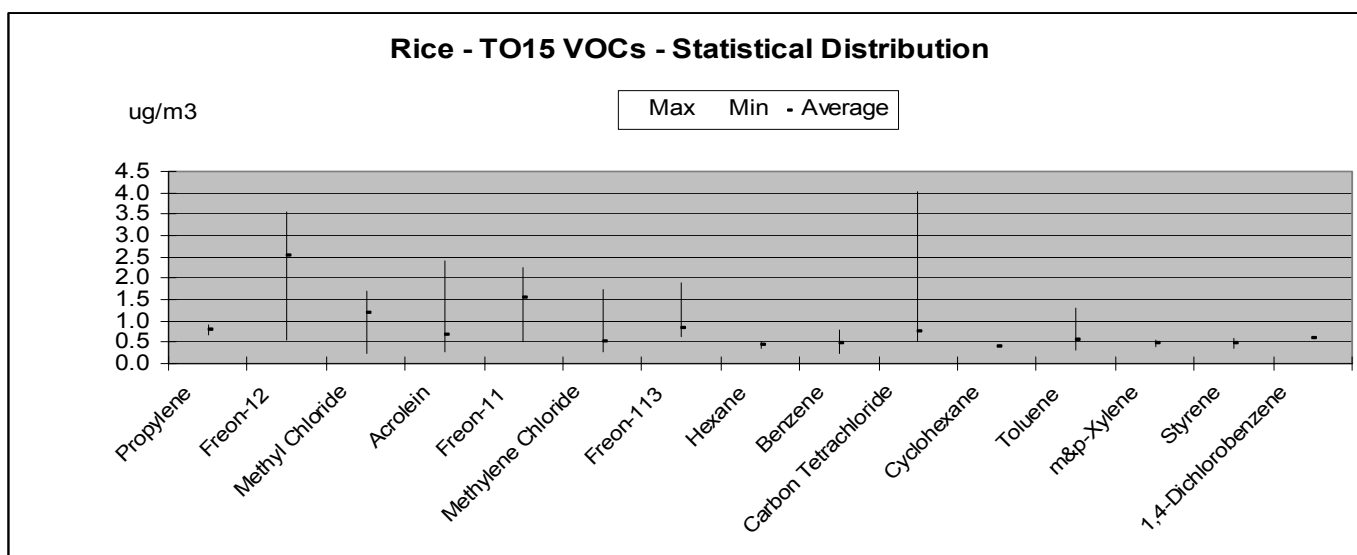
Pollutants	Detection Rate	Pollutants	Detection Rate
Methyl Chloride	97.87%	Toluene	70.21%
Freon-12	96.81%	Acrolein	50.00%
Freon-11	91.49%	Benzene	53.19%
Carbon Tetrachloride	76.60%	Methylene Chloride	47.87%
Freon-113	74.47%		

Table 6.4.6 below lists the statistics for the data results from the samples at the Spruance Site. Acrolein information is provided in this table but was only analyzed with the VOC results beginning in late November 2007. This is due to a change in the methodology used to analyze for Acrolein. The acrolein data listed below does not have one full year's worth of data for comparison. The results listed below are provided in $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter).

Table 6.4.6 VCU Rice Center (downwind) Site VOC results

#	CAS #	AQS	Pollutants (ug/m3)	N	Minimum	Maximum	Median	Average	STD
1	115-07-1	43205	Propylene	2	0.688	0.894	0.791	0.791	0.146
2	75-71-8	43823	Freon-12	91	0.543	3.556	2.618	2.525	0.534
3	74-87-3	43801	Methyl Chloride	92	0.248	1.712	1.196	1.178	0.279
4	107-02-8	43505	Acrolein	26	0.275	2.428	0.618	0.684	0.424
5	75-69-4	43811	Freon-11	86	0.505	2.245	1.600	1.559	0.275
6	75-09-2	43802	Methylene Chloride	45	0.277	1.734	0.486	0.533	0.263
7	76-13-1	43207	Freon-113	70	0.612	1.914	0.804	0.843	0.219
8	100-54-3	43231	Hexane	5	0.352	0.528	0.458	0.451	0.068
9	71-43-2	45201	Benzene	50	0.255	0.798	0.447	0.472	0.153
10	56-23-5	43804	Carbon Tetrachloride	72	0.503	4.022	0.628	0.737	0.466
11	110-87-7	43248	Cyclohexane	1	0.378	0.378	0.378	0.378	
12	108-88-3	45202	Toluene	66	0.301	1.317	0.489	0.549	0.211
13	108-38-3	45109	m&p-Xylene	6	0.390	0.564	0.499	0.492	0.071
14	100-42-5	45220	Styrene	2	0.340	0.596	0.468	0.468	0.181
15	106-46-7	45807	1,4-Dichlorobenzene	1	0.601	0.601	0.601	0.601	

Chart 6.4.3 VCU Rice Center Site VOC results Data Distribution Characteristics



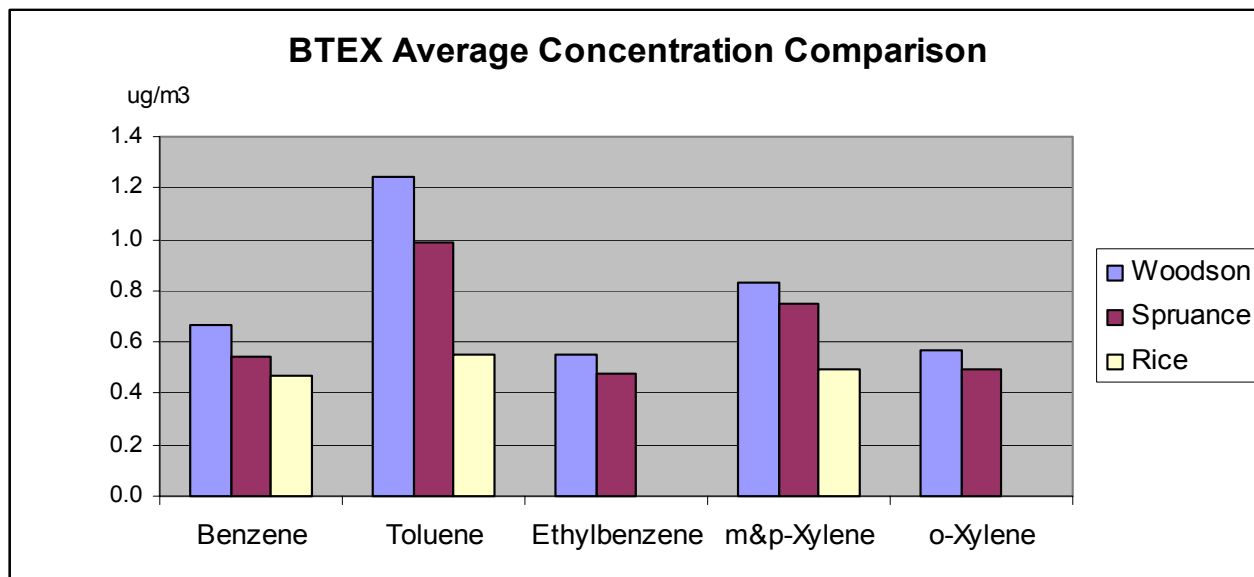
6.4.5 Benzene, Toluene, Ethylbenzene, Xylene (BTEX) Compounds

The following illustrate the comparison of target BTEX compounds measured to evaluate the impact of vehicular emissions. Average concentrations of BTEX compounds were highest at Woodson site possibly due to being located near one of the city's major roadways, school bus traffic and pick-up/drop-off activity.

Table 6.4.7 BTEX results for 3 Hopewell Sites

#	CAS #	AQS	Pollutants (ug/m3)	Woodson	Spruance	Rice
24	71-43-2	45201	Benzene	0.667	0.541	0.472
35	108-88-3	45202	Toluene	1.244	0.985	0.549
40	100-41-4	45203	Ethylbenzene	0.550	0.477	
41	108-38-3	45109	m&p-Xylene	0.835	0.747	0.492
45	95-47-6	45204	o-Xylene	0.566	0.493	

Chart 6.4.4 Graphical presentation of BTEX Results



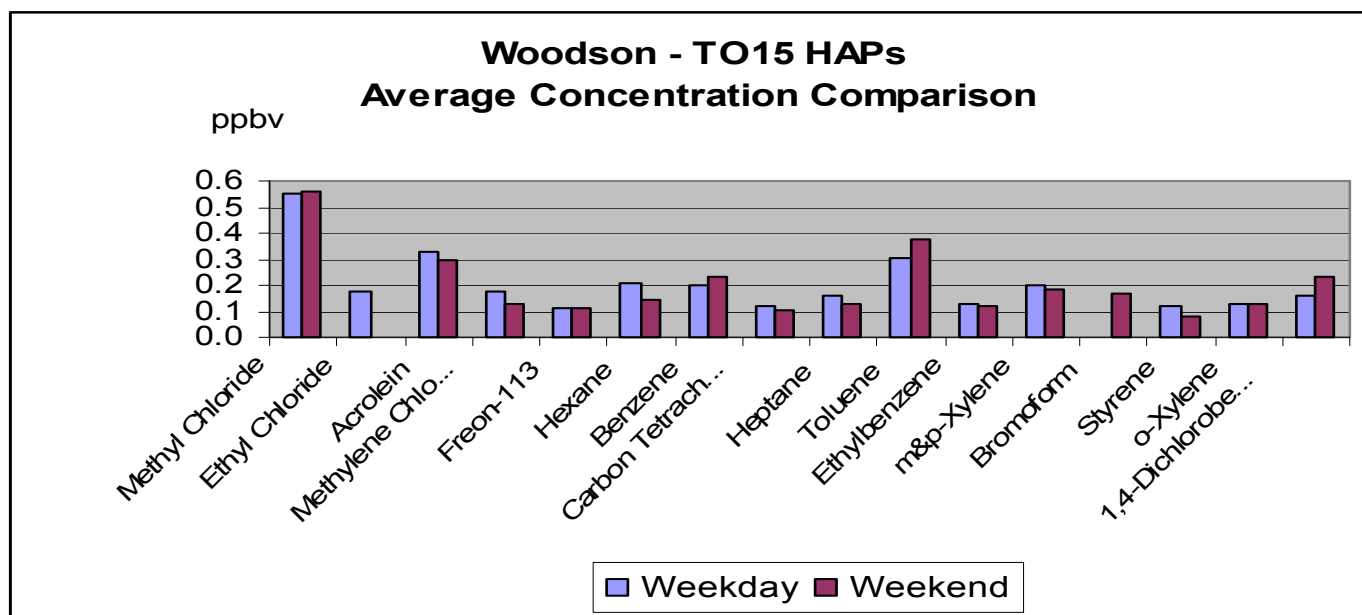
6.4.6 C.G. Woodson (Upwind) Site- Weekday versus Weekend Results

The following illustrate the comparison of target VOC Hazardous Air Pollutants (HAPs) measured during the week to those measured on the weekend at the Woodson site in order to evaluate the affect of traffic patterns and city activities. The average concentration of the detected HAPs at the Woodson site does not appear to provide a definitive indication of a workday versus weekend emissions pattern

Table 6.4.8 Woodson Site VOC HAPs – Weekday versus Weekend

AQS #	Pollutants (ug/m3)	Weekday	Weekend	Difference
43801	Methyl Chloride	1.13	1.16	-2.65%
43812	Ethyl Chloride	0.47		
43505	Acrolein	0.75	0.68	9.33%
43802	Methylene Chloride	0.62	0.45	27.42%
43207	Freon-113	0.84	0.84	0.00%
43231	Hexane	0.70	0.49	30.00%
45201	Benzene	0.64	0.73	-14.06%
43804	Carbon Tetrachloride	0.75	0.63	16.00%
43232	Heptane	0.66	0.53	19.70%
45202	Toluene	1.17	1.43	-22.22%
45203	Ethylbenzene	0.56	0.52	7.14%
45109	m&p-Xylene	0.87	0.82	5.75%
43806	Bromoform		1.76	
45220	Styrene	0.51	0.34	33.33%
45204	o-Xylene	0.56	0.56	0.00%
45807	1,4-Dichlorobenzene	0.96	1.38	-43.75%

Chart 6.4.5 Graphical Representation of Woodson Site VOC HAPs – Weekday versus Weekend



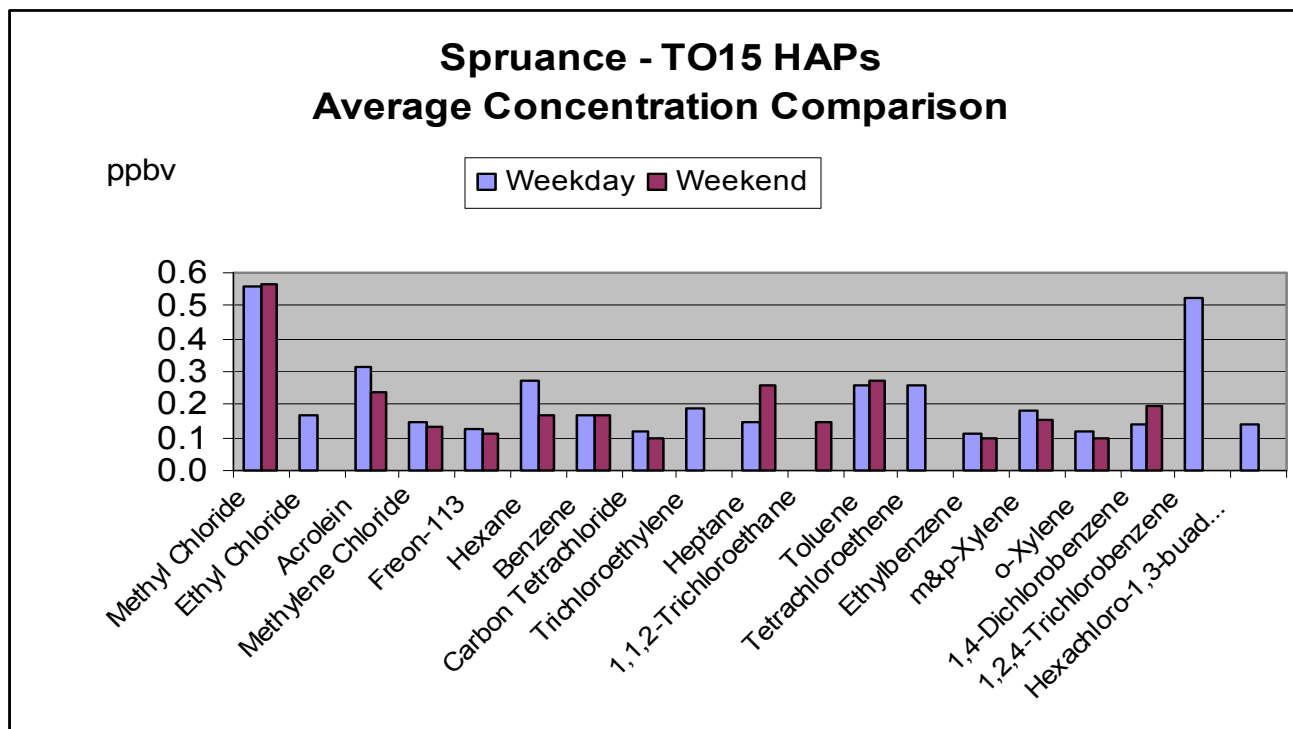
6.4.7 Spruance Road (Central) Site – Weekday versus Weekend

The following illustrate the comparison of target VOC Hazardous Air Pollutants (HAPs) measured during the week to those measured on the weekend at the Spruance site in order to evaluate the affect of traffic patterns and city activities. The average concentration of the detected HAPs at the Spruance site does not appear to provide a definitive indication of a workday versus weekend emissions pattern

Table 6.4.9 Spruance Site VOC HAPs – Weekday versus Weekend

AQS #	Pollutants (ug/m3)	Weekday	Weekend	Difference
43801	Methyl Chloride	1.16	1.18	-1.72%
43812	Ethyl Chloride	0.45		
43505	Acrolein	0.72	0.55	23.61%
43802	Methylene Chloride	0.52	0.45	13.46%
43207	Freon-113	0.92	0.84	8.70%
43231	Hexane	0.95	0.56	41.05%
45201	Benzene	0.54	0.54	0.00%
43804	Carbon Tetrachloride	0.75	0.63	16.00%
43824	Trichloroethylene	1.02		
43232	Heptane	0.57	1.06	-85.96%
43820	1,1,2-Trichloroethane		0.82	
45202	Toluene	0.98	1.02	-4.08%
43817	Tetrachloroethene	1.76		
45203	Ethylbenzene	0.48	0.43	10.42%
45109	m&p-Xylene	0.78	0.65	16.67%
45204	o-Xylene	0.52	0.43	17.31%
45807	1,4-Dichlorobenzene	0.84	1.20	-42.86%
45810	1,2,4-Trichlorobenzene	3.85		
43844	Hexachloro-1,3-buadiene	1.49		

Chart 6.4.6 Graphical Representation of Spruance Site VOC HAPs – Weekday versus Weekend



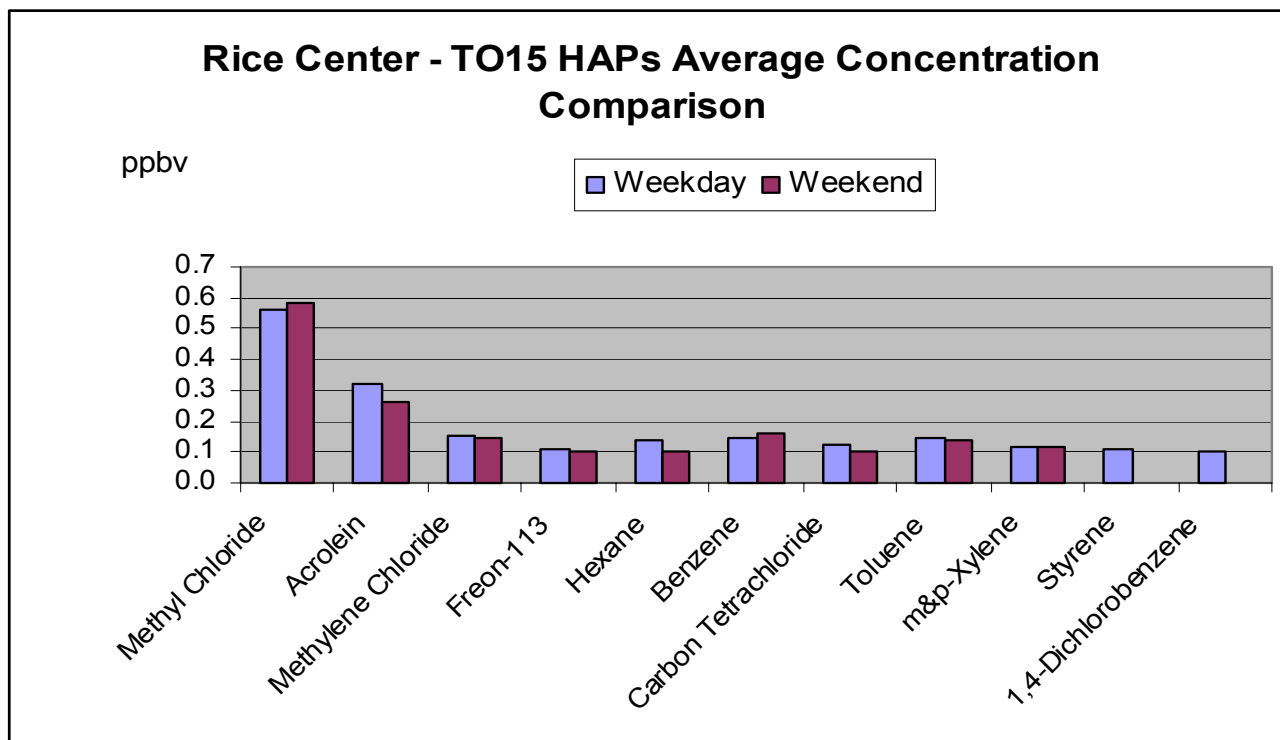
6.4.8. VCU Rice Center (Downwind) Site – Weekday versus Weekend

The following illustrate the comparison of target VOC Hazardous Air Pollutants (HAPs) measured during the week to those measured on the weekend at the VCU Rice Center site in order to evaluate the affect of traffic patterns and city activities. The average concentration of the detected HAPs at the Spruance site does not appear to provide a definitive indication of a workday versus weekend emissions pattern.

Table 6.4.10 VCU Rice Center VOC HAPs – Weekday versus Weekend

AQS #	Pollutants (ug/m3)	Weekday	Weekend	Difference
43801	Methyl Chloride	1.16	1.22	-5.17%
43505	Acrolein	0.71	0.63	11.27%
43802	Methylene Chloride	0.55	0.52	5.45%
43207	Freon-113	0.84	0.77	8.33%
43231	Hexane	0.49	0.35	28.57%
45201	Benzene	0.45	0.51	-13.33%
43804	Carbon Tetrachloride	0.75	0.69	8.00%
45202	Toluene	0.56	0.53	5.36%
45109	m&p-Xylene	0.48	0.48	0.00%
45220	Styrene	0.47		
45807	1,4-Dichlorobenzene	0.60		

Chart 6.4.7 Graphical Representation of VCU Rice Center Site VOC HAPs – Weekday versus Weekend



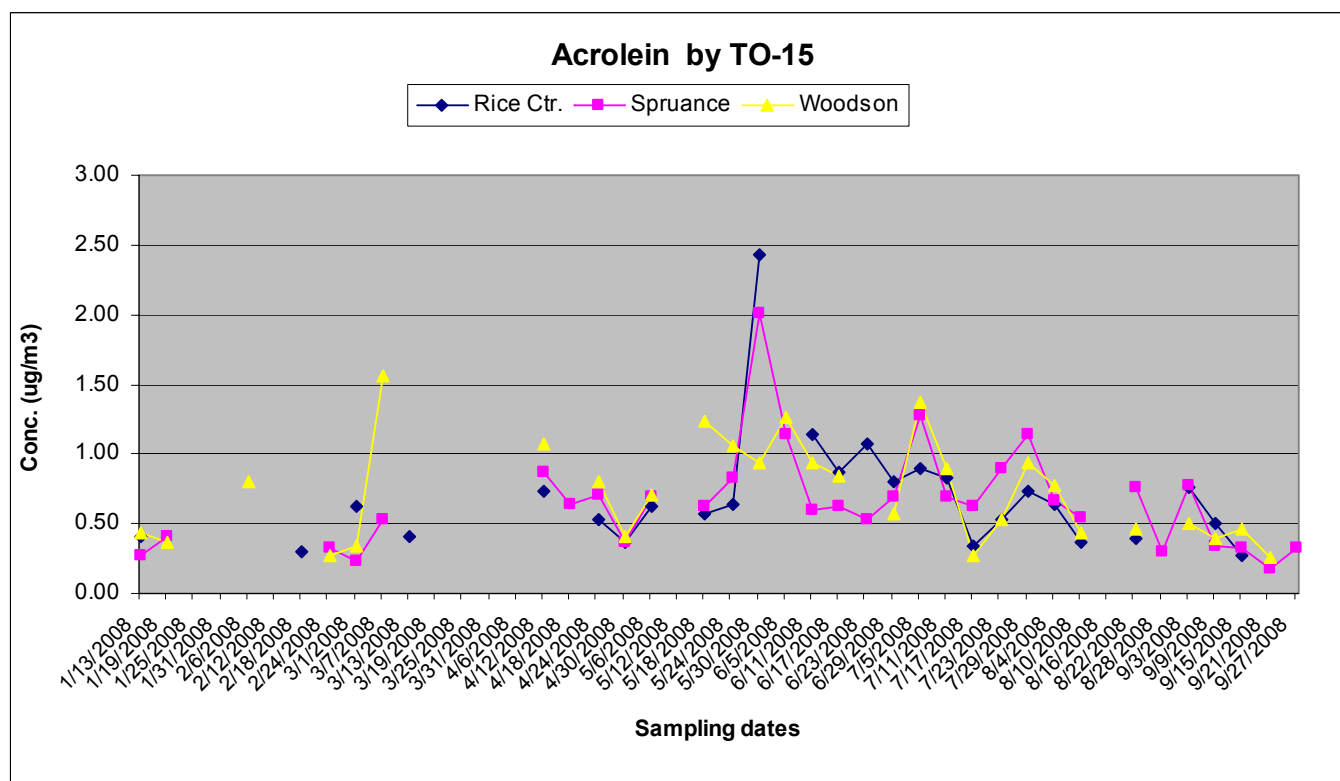
6.4.9 Acrolein Analysis using Method TO-15

DCLS began using method TO15 for the analysis of Acrolein (2-propenal) for samples collected after November 26, 2007. DCLS did not detect Acrolein in the collected samples prior to that date using analysis method TO-11A. The following are summary results for Acrolein from the analysis of 46 samples per sampling site using analysis method TO-15:

Table 6.4.11 Acrolein Statistical Results for 3 Hopewell sites

ug/m3	Woodson	Spruance	Rice Ctr.
N	29	32	26
Min	0.25	0.18	0.27
Max	1.56	2.02	2.43
Median	0.71	0.62	0.62
Average	0.72	0.65	0.68
STD	0.36	0.37	0.42

Chart 6.4.8 Graphical Representation of Acrolein Results for 3 Hopewell Sites



The following table illustrates the comparison of Acrolein measured during the week to those measured on the weekend in order to evaluate the affect of traffic patterns and city activities.

Table 6.4 12 Average Acrolein results for 3 Hopewell Site – Weekday versus Weekend

ug/m3	Woodson	Spruance	Rice Ctr.
All Samples	0.72	0.65	0.68
weekdays	0.75	0.72	0.71
weekend	0.68	0.55	0.63
Difference	9.33%	23.61%	11.27%

Tables 6.4.13 and 6.4.14 below lists Acrolein statistics and concentrations measured at three monitoring sites in Hopewell on weekdays. Based on the available data, it was difficult to identify likely sources for Acrolein emissions in Hopewell because of variability in the detected concentrations at three monitoring sites. Elevated concentrations were measured at all three sites at different times with various meteorological conditions.

Table 6.4.13 Acrolein Statistical Results for Weekday Samples from 3 Hopewell Sites

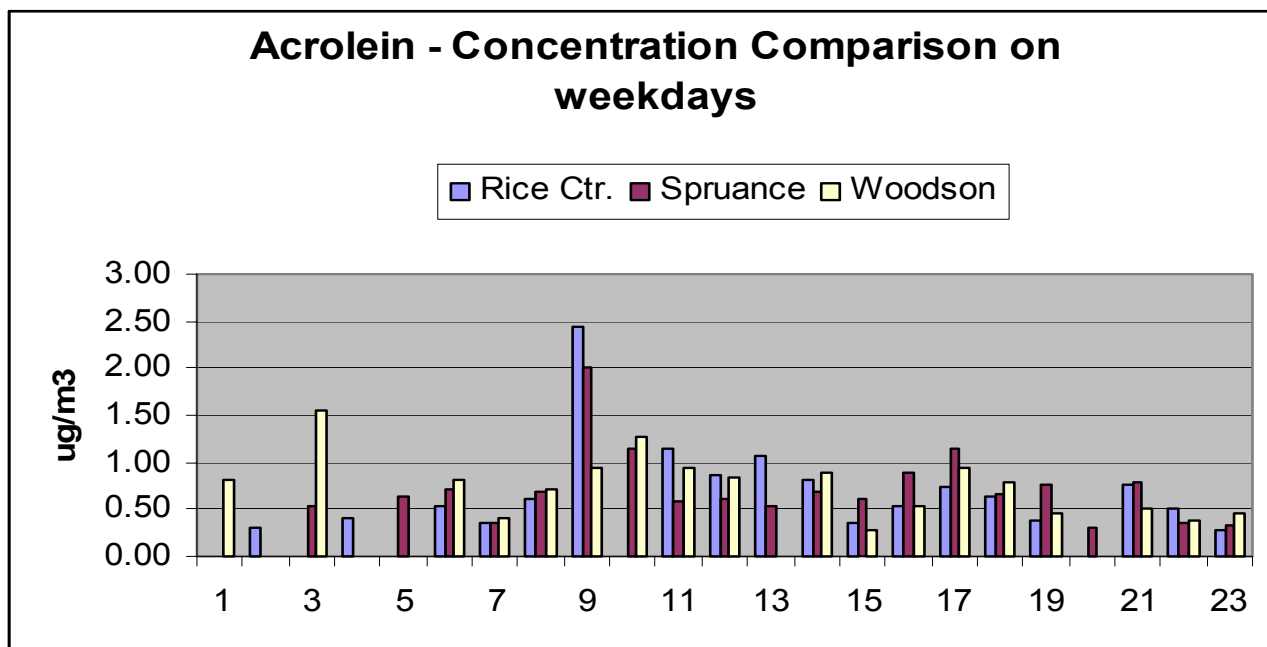
ug/m3	Woodson	Spruance	Rice Ctr.
N	18	20	18
Min	0.27	0.30	0.27
Max	1.56	2.02	2.43
Median	0.79	0.65	0.58
Average	0.75	0.72	0.71
STD	0.33	0.39	0.50

Table 6.4.14 Acrolein Results for Weekday Samples ($\mu\text{g}/\text{m}^3$) with Meteorological Data Examples

N	Sampling date	Woodson	Spruance	Rice Ctr.	Meteorological Correlations
1	2/6/08	0.80			Example 1 July 29 & August 16, 2008: With a primary wind direction from the East Southeast on July 29, 2008, Spruance had an Acrolein concentration of 1.15 $\mu\text{g}/\text{m}^3$ and on August 16, 2008 with a similar wind direction Acrolein was not detected at any site.
2	2/18/08			0.30	
3	3/7/08	1.56	0.53		
4	3/13/08			0.41	
5	4/18/08		0.64		
6	4/24/08	0.80	0.71	0.53	
7	4/30/08	0.41	0.37	0.37	
8	5/6/08	0.71	0.69	0.62	
9	5/30/08	0.94	2.02	2.43	
10	6/5/08	1.26	1.15		
11	6/11/08	0.94	0.60	1.15	Example 2 February 6, 2008: Acrolein was not detected on February 6, 2008 at both Rice and Spruance but had a detected concentration measured at Woodson. The wind direction at Woodson was from the South with fairly high wind speed.
12	6/17/08	0.85	0.62	0.87	
13	6/23/08		0.53	1.08	
14	7/11/08	0.89	0.69	0.82	
15	7/17/08	0.27	0.62	0.34	
16	7/23/08	0.53	0.89	0.53	
17	7/29/08	0.94	1.15	0.73	
18	8/4/08	0.78	0.66	0.64	
19	8/22/08	0.46	0.76	0.39	
20	8/28/08		0.30		
21	9/3/08	0.50	0.78	0.76	Example 3 March 7, 2008: Acrolein had an detected concentration in the samples collected at Woodson and Spruance on March 7, 2008 while not detected in Rice's sample. The primary wind direction was from the North Northeast
22	9/9/08	0.39	0.34	0.50	
23	9/15/08	0.46	0.32	0.27	

From these three examples, no assumption can be made that the source of the Acrolein can be determined based solely on meteorological data.

Chart 6.4.9 Graphical Presentation of Acrolein Results for 3 Hopewell sites - Weekdays



Tables 6.4.15 and 6.4.16 list Acrolein statistics and concentrations measured at three monitoring sites in Hopewell on weekend days. The results for the Spruance site indicate a lower overall weekend average versus the Woodson (19%) and the VCU Rice Center site (13%). The variability for the Woodson site data set (± 0.42 ; 62%) and the Spruance site data set (± 0.33 ; 64%) are both higher than the Rice Center site data set (± 0.18 ; 29%). The Rice Center site also had fewer detectable samples.

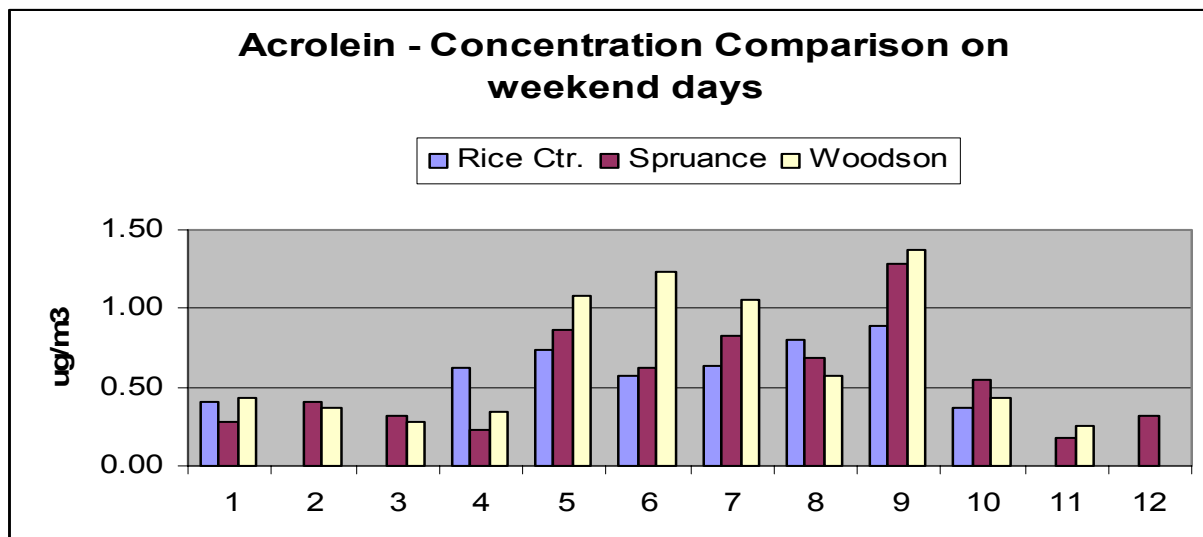
Table 6.4.15 Acrolein Statistical Results for Weekend Samples from 3 Hopewell Sites (ug/m3)

ug/m3	Woodson	Spruance	Rice Ctr.
N	11	12	8
Min	0.25	0.18	0.37
Max	1.37	1.28	0.89
Median	0.44	0.48	0.63
Average	0.68	0.55	0.63
STD	0.42	0.33	0.18

Table 6.4.16 Acrolein Results for Weekend Samples (ug/m3)

N	Weekend days	Woodson	Spruance	Rice Ctr.
1	1/13/08	0.44	0.27	0.41
2	1/19/08	0.37	0.41	
3	2/24/08	0.27	0.32	
4	3/1/08	0.34	0.23	0.62
5	4/12/08	1.08	0.87	0.73
6	5/18/08	1.24	0.62	0.57
7	5/24/08	1.05	0.82	0.64
8	6/29/08	0.57	0.69	0.80
9	7/5/08	1.37	1.28	0.89
10	8/10/08	0.44	0.55	0.37
11	9/21/08	0.25	0.18	
12	9/27/08		0.32	

Chart 6.4.10 Graphical Presentation of Acrolein Results for 3 Hopewell sites – Weekends



6.4.10 Hopewell Sites compared to Urban Sites (UATM) for VOC HAPs

The following table compares concentrations of Acrolein measured by method TO-15 in Hopewell with the Acrolein data collected at three existing Virginia Urban Air Toxic sampling sites from Jan 1, 2008 to September 30, 2008. The data is presented in 4 different methods for handling non-detectable samples: None – no non-detectable information used in the calculation; MDL = 0 – non-detectable data entered as zero; 1/2 MDL – non-detectable data is included as 1/2 the Method detection level. MDL – non-detectable data is included as the Method detection level The urban toxics sites are as follows:

Fairfax:	Lee District Park	Lee
Richmond:	MathScience Innovation Center	MSIC
TRO:	DEQ Tidewater Regional Office	Virginia Beach

6.4.17 Hopewell Acrolein Concentrations Compared to Urban Toxics Sites 1/1/2008 – 9/30/2008 (ug/m3)

Value assigned to non-detected sample (ug/m3)	Hopewell			UATM		
	Woodson	Spruance	Rice	Lee	MSIC	TRO
None	0.721	0.654	0.684	0.368	0.576	0.388
<MDL = 0	0.455	0.455	0.386	0.344	0.526	0.380
< MDL = 1/2 MDL	0.468	0.465	0.402	0.345	0.528	0.380
<MDL = MDL	0.481	0.476	0.417	0.346	0.531	0.381

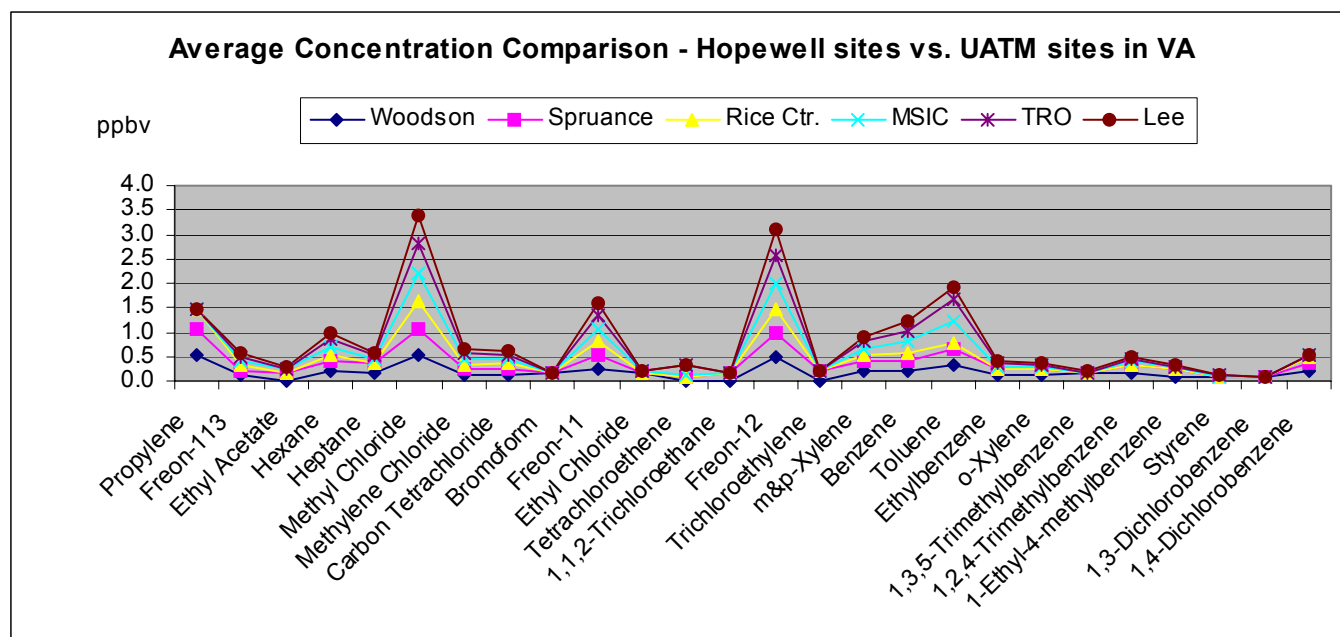
The following table illustrates the comparison between average concentration of the detected VOC in Hopewell over the whole sampling period and the annual average concentration of those detected at the three Urban Air Toxics Monitoring (UATM) sites in Virginia in 2007 **Please note: Urban Air Toxics data uses the total number of samples including concentrations reported below the detectable level for the calculation of averages while this studies' averages are based only on the number of detected samples.**

Table 6.4.18 Hopewell VOC Concentrations Compared to Urban Toxics Sites

CAS #	Pollutants (ug/m3)	Woodson	Spruance	Rice Ctr.	Lee	MSIC	TRO
76-13-1	Freon-113	0.77	0.92	0.84	0.67	0.67	0.65
141-78-6	Ethyl Acetate		0.61		0.05	0.23	0.11
100-54-3	Hexane	0.67	0.74	0.49	0.34	0.56	0.59
142-82-5	Heptane	0.70	0.78		0.17	0.35	0.28
74-87-3	Methyl Chloride	1.09	1.09	1.13	1.16	1.24	1.27
75-09-2	Methylene Chloride	0.38	0.42	0.42	0.28	0.30	0.42
56-23-5	Carbon Tetrachloride	0.75	0.75	0.75	0.52	0.49	0.53
75-25-2	Bromoform	1.76				0.01	
75-69-4	Freon-11	1.46	1.52	1.52	1.48	1.54	1.46
75-00-3	Ethyl Chloride	0.47			0.01	0.03	0.02
127-18-4	Tetrachloroethene		0.54		0.22	0.24	1.30
79-00-5	1,1,2-Trichloroethane		0.82			0.01	
75-71-8	Freon-12	2.42	2.37	2.47	2.73	2.69	2.74
79-01-6	Trichloroethylene		1.02		0.05	0.02	0.04
108-38-3	m&p-Xylene	0.95	0.82	0.52	0.35	0.62	0.61

71-43-2	Benzene	0.70	0.61	0.48	0.61	0.78	0.72
108-88-3	Toluene	1.24	1.17	0.56	0.99	1.69	1.62
100-41-4	Ethylbenzene	0.52	0.52		0.16	0.26	0.26
95-47-6	o-Xylene	0.52	0.48		0.13	0.25	0.23
108-67-8	1,3,5-Trimethylbenzene	0.74			0.04	0.08	0.08
95-63-6	1,2,4-Trimethylbenzene	0.88	0.74		0.17	0.30	0.28
622-96-8	1-Ethyl-4-methylbenzene	0.39	0.83		0.08	0.13	0.12
100-42-5	Styrene	0.34			0.05	0.07	0.09
541-73-1	1,3-Dichlorobenzene	0.60				0.01	
106-46-7	1,4-Dichlorobenzene	1.26	1.08	0.60	0.05	0.17	0.08

Chart 6.4.11 Graphical Presentation of VOC Comparison – Hopewell vs. UATM Sites

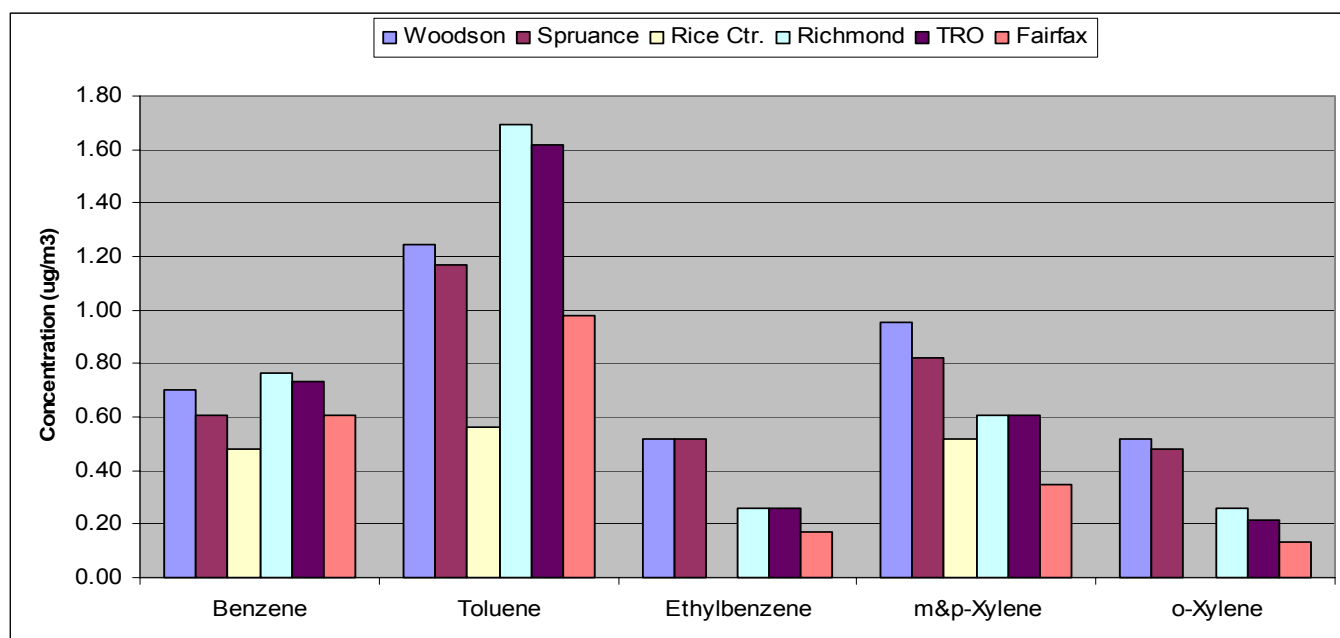


The following table compares BTEX concentrations measured in Hopewell for only 2007 with those measured at the other Virginia Urban Air Toxic Monitoring sites in 2007. **Please note: Urban Air Toxics data uses the total number of samples including concentrations reported below the detectable level for the calculation of averages while this studies' averages are based only on the number of detected samples.**

Table 6.4.19 Hopewell BTEX Concentrations (2007) Compared to Urban Toxics Sites (2007)

CAS #	Pollutants (ug/m3)	Woodson	Spruance	Rice Ctr.	Lee	MSIC	TRO
71-43-2	Benzene	0.70	0.61	0.48	0.61	0.77	0.72
108-88-3	Toluene	1.24	1.17	0.56	0.99	1.69	1.62
100-41-4	Ethylbenzene	0.52	0.52		0.16	0.26	0.26
108-38-3	m&p-Xylene	0.95	0.82	0.52	0.35	0.62	0.61
95-47-6	o-Xylene	0.52	0.48		0.13	0.25	0.23

Chart 6.4.11 Graphical Presentation of BTEX Comparison – Hopewell vs. UATM Sites (2007)

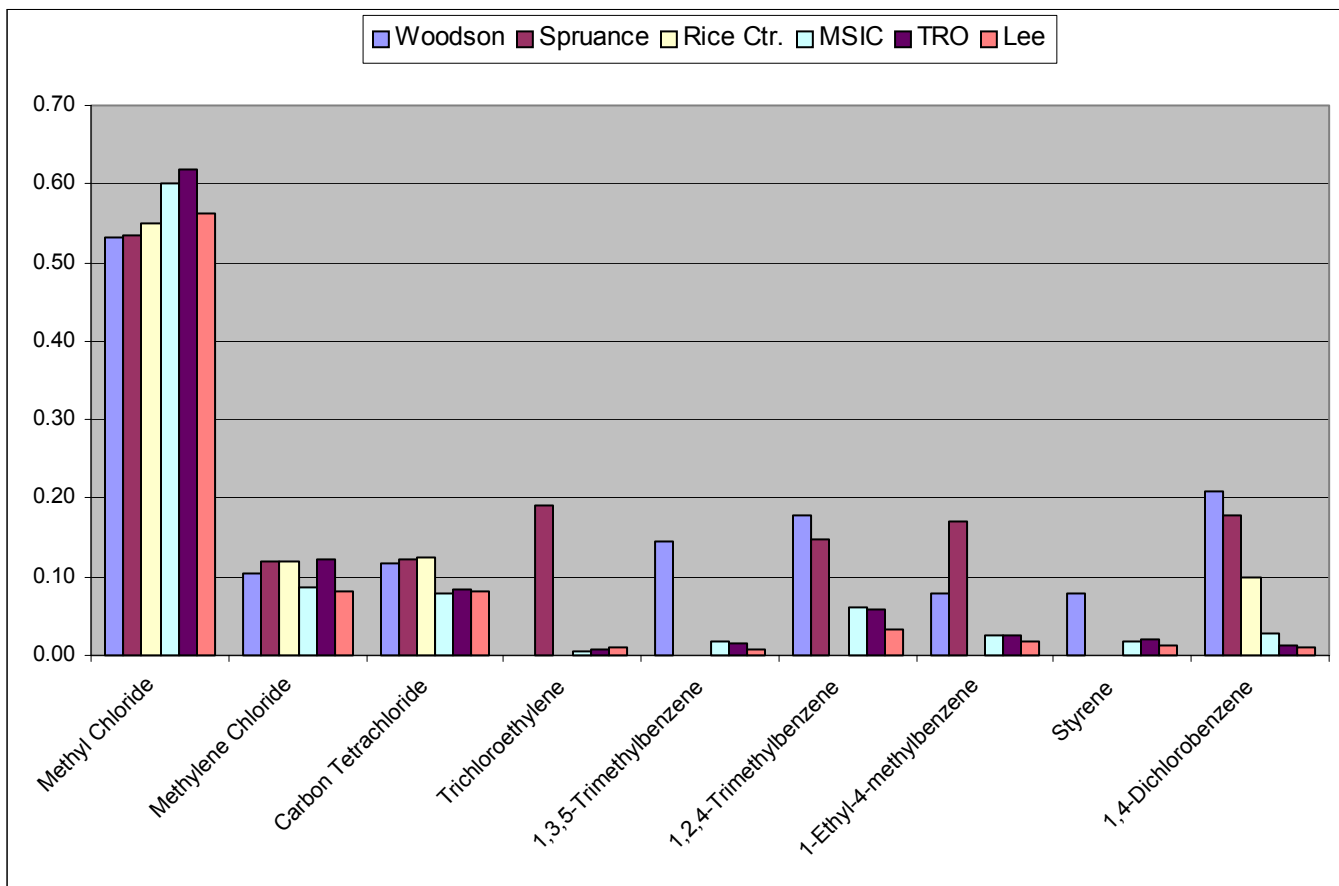


The following table compares other VOCs concentrations measured in Hopewell for calendar year 2007 with those measured at the other Urban Air Toxic Monitoring sites in Virginia for calendar year 2007. **Please note:** Urban Air Toxics data uses the total number of samples including concentrations reported below the detectable level for the calculation of averages while this studies' averages are based only on the number of detected samples.

Table 6.4.20 Hopewell VOC Concentrations (2007) Compared to Urban Toxics Sites (2007)

CAS #	Pollutants	Woodson	Spruance	Rice Ctr.	Lee	MSIC	TRO
74-87-3	Methyl Chloride	1.10	1.10	1.14	1.16	1.24	1.28
75-09-2	Methylene Chloride	0.36	0.42	0.42	0.29	0.30	0.42
56-23-5	Carbon Tetrachloride	0.74	0.77	0.78	0.51	0.49	0.53
79-01-6	Trichloroethylene		1.02		0.05	0.02	0.03
108-67-8	1,3,5-Trimethylbenzene	0.71			0.04	0.08	0.08
95-63-6	1,2,4-Trimethylbenzene	0.88	0.73		0.17	0.31	0.28
622-96-8	1-Ethyl-4-methylbenzene	0.39	0.83		0.08	0.13	0.12
100-42-5	Styrene	0.34	0.00		0.05	0.07	0.09
106-46-7	1,4-Dichlorobenzene	1.25	1.07	0.60	0.05	0.17	0.08

Chart 6.4.11 Graphical Presentation of VOC Comparison – Hopewell (2007) vs. UATM Sites (2007)



6.5. Hexavalent Chromium Sampling:

DCLS analyzed filter samples collected at the Woodson site by a modified California Method 39. Hexavalent Chromium, or Chrome VI, is generally produced by the Chemical and Electroplating industries. Chrome VI is used for chrome plating, paints, inks, anti-corrosion coatings, textiles, copying machines toners, leather tanning, and wood preserving.

AQM did not blank correct lab results although Hexavalent Chromium did have a relatively high blank concentration. This was done to provide the most conservative approach to the data. Blank data for Chrome VI should be considered when performing risk evaluations

Table 6.5.1 Blank Correction Factors

ng/m3	Woodson	Spruance	Rice
Blank Average	0.101	0.057	0.087

Table 6.5.2 summarizes the results of Hexavalent Chromium measured in the project. The unit of concentration is nanograms per cubic meter (ng/ m³).

Table 6.5.2 – Hexavalent Chrome Statistical Results for 3 Hopewell Sites

ng/m3	Woodson	Spruance	Rice
N	79	89	79
Min	0.000	0.000	0.000
Max	1.222	0.673	0.473
Median	0.130	0.115	0.155
Average	0.171	0.134	0.164
STD	0.171	0.108	0.105

The following compares the results of Hexavalent Chromium with other target metals measured in the project. The unit of concentration is nanograms per cubic meter (ng/ m³).

Table 6.5.3 – Hexavalent Chrome Comparison with other Metals for 3 Hopewell Sites

ng/m3	Woodson	Spruance	Rice
Cr6+	0.171	0.134	0.164
Cr	3.171	3.057	2.62
Be	0.037	0.049	0.050
Mn	3.460	3.598	2.890
Ni	1.693	1.414	1.110
As	1.035	1.024	0.800
Cd	0.208	0.157	0.150
Pb	3.190	3.017	2.590

The following tables summarize the data for Chrome VI collected at three sampling sites on weekdays and weekend days. Table 6.5.4 provides the statistical information while Table 6.5.5 provides the comparison of the weekday and weekend average concentrations.

Table 6.5.4 – Chrome VI Statistical Results for Weekday and Weekend Samples from 3 Hopewell Sites

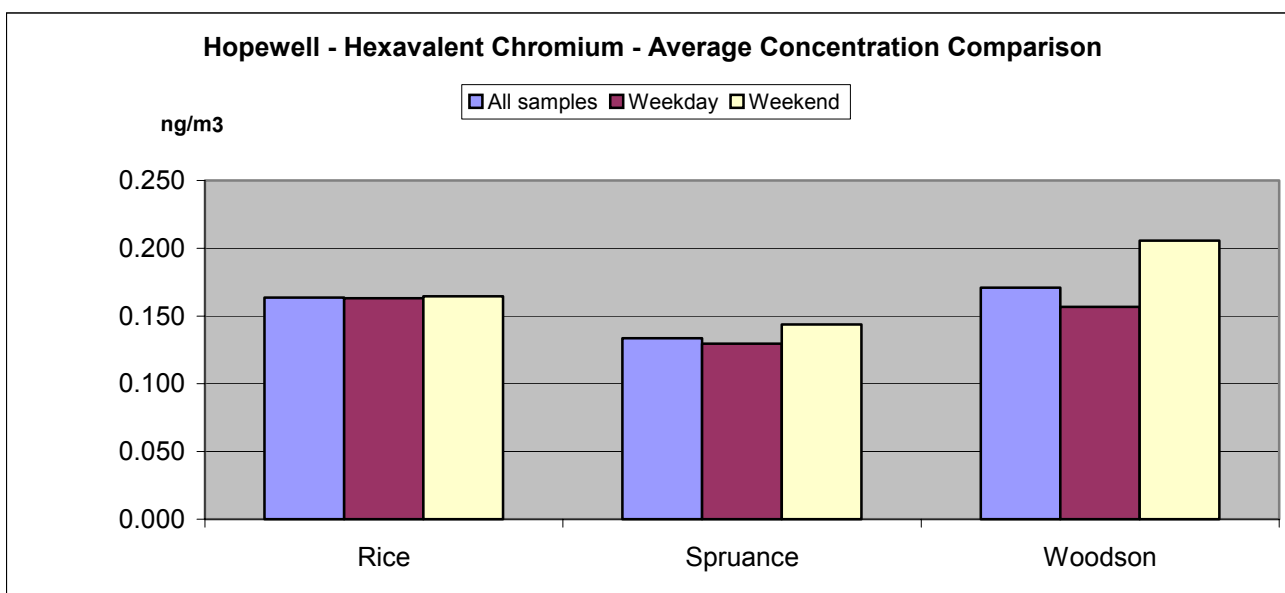
	Woodson		Spruance		Rice center	
ng/m3	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
N	56	23	63	25	56	24
Min	0.000	0.016	0.000	0.024	0.000	0.014
Max	0.726	1.222	0.673	0.342	0.473	0.328
Median	0.130	0.134	0.100	0.129	0.155	0.147
Average	0.157	0.206	0.130	0.144	0.163	0.164
STD	0.124	0.251	0.117	0.085	0.111	0.088

Table 6.5.5 Comparison of Chrome VI Weekday and Weekend Averages for 3 Hopewell Sites

ng/m3	Woodson	Spruance	Rice Ctr.
weekdays	0.157	0.130	0.163
weekend	0.206	0.144	0.164
Difference	-31.21%	-10.77%	-0.61%

The average concentration of Chrome VI measured at three Hopewell sampling site was less than 0.001 $\mu\text{g}/\text{m}^3$, (1 nanogram per cubic meter) which was below the national average. Average atmospheric concentrations of chromium from more than 2,100 monitoring stations ranged from 0.005 $\mu\text{g}/\text{m}^3$ to 0.525 $\mu\text{g}/\text{m}^3$ (ATSDR 2000). Also, a 1990 study reported an average concentration of Chrome VI ranging from less than 0.001 $\mu\text{g}/\text{m}^3$ to 3 $\mu\text{g}/\text{m}^3$ (ATSDR 2000).

Chart 6.5.1 Graphical Presentation of Chrome VI concentrations for 3 Hopewell Sites



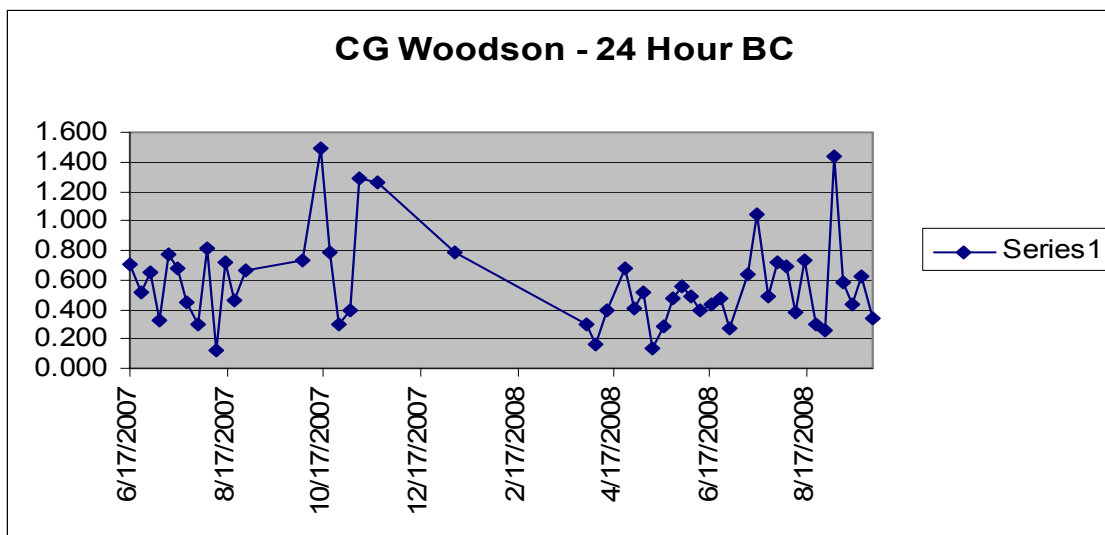
6.6 BLACK CARBON SAMPLING:

AQM experienced a number of instrumentation breakdowns of the Magee AE-42 Aethalometer that caused loss of the collected data. The followings summarize data collected in the project and in the same sampling dates with other instrument used in the project.

Table 6.6.1 Black Carbon Statistical Results: All data vs. Sampling Day Data (nanograms per cubic meter)

Daily Average, All Data			Daily Average, Sample Days		
N	308		N	50	
Min	0.12	ng/m3	Min	0.119	ng/m3
Max	2.40	ng/m3	Max	1.497	ng/m3
Median	0.52	ng/m3	Median	0.500	ng/m3
Avg	0.60	ng/m3	Avg	0.577	ng/m3
STD	0.329	ng/m3	STD	0.310	ng/m3

Chart 6.6.1 Graphical presentation of Sample day Black Carbon information for Woodson Site



The collected data demonstrated low level of Black Carbon emitted in the area. By comparing with PM2.5 data collected in 2006 and 2007 in the surrounding locations, Black Carbon is an insignificant component species in the PM2.5 compositions.

Table 6.6.2 PM2.5 results from other sites Comparison to Black Carbon Content (micrograms per cubic meter)

PM2.5 (ug/m3)				Black Carbon (ug/m3)	
	Site	2006	2007	All Data	Sample Days
Chesterfield	Beach Road	13.1	13	0.000600	0.000577
Henrico	MSIC	13.2	12.5		
Charles City	Shirley	12	11.9		

The following table summarizes data of Black Carbon collected at the C.G. Woodson site on weekdays and weekend days. Average concentration of Black Carbon was lower on weekend days due to lesser traffic condition.

Table 6.6.3 Black Carbon Statistical Results – Weekday vs. Weekend

Sample Days, Weekday		
N	35	
Min	0.119	ng/m3
Max	1.497	ng/m3
Median	0.552	ng/m3
Avg	0.623	ng/m3
STD	0.336	ng/m3

Sample Days, Weekend		
N	15	
Min	0.164	ng/m3
Max	0.816	ng/m3
Median	0.390	ng/m3
Avg	0.470	ng/m3
STD	0.211	ng/m3

All Data, Weekday (all)		
N	219	
Min	0.119	ng/m3
Max	1.234	ng/m3
Median	0.552	ng/m3
Avg	0.640	ng/m3
STDV	0.351	ng/m3

All Data, Weekend (all)		
N	89	
Min	0.164	ng/m3
Max	0.816	ng/m3
Median	0.455	ng/m3
Avg	0.487	ng/m3
STDV	0.237	ng/m3

Table 6.6.4 Black Carbon results Comparison – Weekday vs. Weekend

ng/m3	weekdays	weekend	Difference
Sample Days	0.623	0.470	24.56%
All Data	0.640	0.487	23.91%

7.0. DATA COMPARISON WITH 1999 NATA:

National-scale Air Toxic Assessment (NATA) is a US EPA project, which used the 1999 air toxics inventories and an air toxics modeling approach to assess ambient air toxics, emission source types, and locations. The NATA 1999 includes 177 air pollutants (a subset of the air toxics on the Clean Air Act's list of 187 air toxics plus diesel particulate matter (diesel PM). EPA is currently reviewing the 2002 NATA report; it will be available to the public in the near future. For the 1999 national-scale assessment, EPA provided a limited number of air toxics with estimated concentrations at the county level.

The following table is for the comparison of limited monitoring data with values of pollutants reported in the NATA 1999 for the City of Hopewell. Chloroform was not detected in the Hopewell study. The NATA 1999 over-estimated Toluene concentration in Hopewell. Concentration of Acetaldehyde, Benzene, Methyl Chloride, Methylene Chloride, and Xylenes were in line with those estimated by the NATA 1999. Acrolein, Formaldehyde, Carbon Tetrachloride, and Hexane had higher average concentrations than those reported by the NATA 1999.

Table 7.0.1 Comparison of Median values – NATA 1999 effort and Hopewell study

Pollutants	Median (ug/m3)					
	NATA 1999			Hopewell		
	Nationwide	Virginia	Hopewell	Woodson	Spruance	Rice
Acrolein	0.08	0.05	0.06	0.71	0.62	0.62
Acetaldehyde	1.21	1.07	1.53	1.70	1.81	1.41
Benzene	1.16	0.92	0.74	0.56	0.51	0.45
Carbon Tetrachloride	0.27	0.27	0.36	0.63	0.63	0.63
Chloroform	0.07	0.07	0.52	NA	NA	NA
Formaldehyde	1.38	1.16	1.15	2.45	2.59	2.98
Methyl Chloride	1.21	1.20	1.21	1.13	1.18	1.20
Methylene Chloride	0.48	0.38	0.34	0.42	0.42	0.49
Hexane	0.52	0.35	0.26	0.53	0.74	0.46
Toluene	2.21	1.72	1.62	0.88	0.79	0.49
Xylenes*	1.60	1.24	1.07	1.04	1.15	0.50

- NATA 1999 Xylenes are all isomers consists of o, m&p Xylene

Table 7.0.2 Comparison of Mean values – NATA 1999 effort and Hopewell study

Pollutants	Total Mean (ug/m3)					
	NATA 1999			Hopewell		
	Nationwide	Virginia	Hopewell	Woodson	Spruance	Rice
Acrolein	0.11	0.06	0.06	0.721	0.65	0.68
Acetaldehyde	1.41	1.11	1.54	1.87	1.96	1.41
Benzene	1.37	1.00	0.82	0.667	0.54	0.472
Carbon Tetrachloride	0.28	0.27	0.35	0.704	0.71	0.737
Chloroform	0.09	0.08	0.47	NA	NA	NA
Formaldehyde	1.59	1.14	1.16	2.96	3.22	3.62
Methyl Chloride	1.22	1.21	1.21	1.146	1.16	1.18
Methylene Chloride	0.63	0.38	0.36	0.565	0.49	0.533
Hexane	0.83	0.39	0.29	0.640	0.83	0.451
Toluene	3.02	2.01	1.85	1.244	0.98	0.549
Xylenes*	2.23	1.42	1.17	1.402	1.24	0.492

* NATA 1999 Xylenes are all isomers consists of o, m&p Xylene

Table 7.0.3 NATA Assessment – Estimated Background Concentration

Pollutants	Average Concentration µg/m3			
	Background	Woodson	Spruance	Rice
Acetaldehyde	0.56	1.87	1.96	1.41
Formaldehyde	0.78	2.96	3.22	3.62

AQM can not perform a 1 to 1 comparison for the target metals because of the project's sample collection media. AQM used a PM-10 method to collect a smaller particulate size than one reported by the NATA 1999. Table 7.0.4 lists the estimated NATA's concentration and monitored metals data collected from the project in nanograms per cubic meter.

Table 7.0.4 Comparison of Mean Metal Values – NATA vs. 3 Hopewell Sites

Total Mean (ng/m3)	NATA 1999			Hopewell		
	Nationwide	Virginia	Hopewell	Woodson	Spruance	Rice
Arsenic	0.21	0.15	0.42	1.03	1.04	0.81
Cadmium	0.26	0.04	0.03	0.21	0.16	0.15
Lead	4.66	1.47	3.12	3.17	3.04	2.56
Manganese	4.99	1.14	1.69	3.47	3.66	2.9
Nickel	2.39	0.92	1.42	1.67	1.43	1.09
Beryllium	0.05	0.01	0.01	0.04	0.05	0.05
Chromium	NA	NA	NA	3.14	3.03	2.6
Chrome VI	0.34	1.41	0.69	0.18	0.14	0.18

8.0. CONCLUSION:

The special grant provided by the US EPA's OAQPS has enabled VADEQ to collect valuable information on the quality of air in Hopewell City and its surrounding areas. VADEQ and the stakeholders viewed this project as an important first step in the study of air quality and health aspect of selected ambient air toxic pollutants in the Hopewell City. The collected data established a baseline of air quality concentrations for the sampled pollutants in Hopewell. The information may be useful for future evaluation for the progress of an emission control program. Based on the collected data of the project, VADEQ has preliminarily found the following conclusions for this project:

Metals

- PM-10 emissions in Hopewell were in line with other locations in Virginia. Also, PM-10 was not affected by increased activities on weekdays in Hopewell. VADEQ has decided to upgrade the PM-10 monitor at Woodson to a long term monitoring site.
- Based on this project monitoring data, The 1999 NATA report underestimated the target metals with the exception of Lead, Nickel, and Chrome VI. Chromium (Cr), Manganese (Mn), and Lead (Pb) were the greatest contributors towards the total metal composition in the PM-10 samples collected. Average concentration of Lead measured at the three sites in Hopewell was much lower than the new allowable concentration of $0.15 \mu\text{g}/\text{m}^3$.
- Metals weekday versus weekend concentration trends appear consistent with expected weekday/weekend activities.

Carbonyls:

- Out of seven target compounds, there were five Carbonyl compounds found in Hopewell: Formaldehyde, Acetaldehyde, Acetone, Methyl Ethyl Ketone (MEK), and Propionaldehyde. Among the detected carbonyls, Acetone and MEK were not HAPs. Methyl Isobutyl Ketone concentrations were below the MDL in all collected samples. Acrolein analytical method was changed from method TO-11A to Method TO-15 due to a limitation in the TO-11A method.
- Although Formaldehyde measured higher than the background and the estimated concentrations listed in the NATA 1999, the detected concentrations are similar to levels of measured concentrations in other locations in Virginia. Unexpected elevated Formaldehyde concentrations were monitored at the VCU Rice Center and appear to correlate with construction activity at the facility in late 2007.
- Except MEK measured on weekend days at Spruance, traffic and daily activities do not appear to be the major predictor of weekday versus weekend concentrations for the target carbonyls emission in the study area.
- The 1999 NATA underestimated concentration of Acrolein, Acetaldehyde, and Formaldehyde.

Volatile Organic Compounds:

- From the list of 53 targeted Volatile Organic Compounds, there were only 9 to 16 frequently detected VOC (detection rate was equal or greater than 10%) at the three sampling sites in Hopewell. The measured, average concentrations of the detected VOCs were comparable to those sampled at Richmond, Norfolk, VA Beach and Fairfax.

- Acrolein shows a consistently higher concentration on weekdays versus weekend days. Acrolein appears to be a regional pollutant contributed by regional activities and traffic volume. VADEQ continues to collect Acrolein data at the Spruance site for a complete calculation of its annual average concentration.
- Comparison between Hopewell results and the Urban Air Toxics Sites in Virginia indicates no clear pattern when comparing the worst case Hopewell study numbers versus the UATM concentrations using EPA's database protocols.
- The 1999 NATA underestimated concentration of Acrolein and Hexane.

Hexavalent Chromium:

- Detected levels of Chrome VI indicate that it is not a problem in Hopewell City based on OSHA 8 Hour time weighted average (TWA).
- Average concentration of Hopewell Chrome VI is at the below the National average atmospheric concentration of $0.001 \mu\text{g}/\text{m}^3$

Black Carbon:

- Black Carbon concentration was not an issue in Hopewell.
- Based on the difference between the weekday and weekend concentrations, vehicular emission and commercial/ industrial activity appear to be a major contributors of the pollutant in Hopewell.

NATA 1999:

- NATA over predicted the concentrations of Benzene, Chloroform, Toluene and Chrome VI.
- NATA under predicted concentrations of Acrolein, Acetaldehyde, Carbon Tetrachloride, Formaldehyde, Methylene Chloride, Hexane.
- Estimates of the other available compounds compare favorably to the observed values

Project Update:

DEQ has upgraded the Woodson site to an Urban Air Toxics Monitoring (UATM) site for long term studies on Ambient Air Toxics in the area. EPA has granted an extension for the project for DEQ to continue monitoring VOCs and begin to collect sample for Sulfur and Polycyclic Aromatic Hydrocarbons (PAHs) compounds at the Spruance site and low volume PM10 metals at the C.G. Woodson site.

Additional data analysis and a subsequent Health Assessment in the Hopewell area may be beneficial. The additional task could be a major project depending on its scope. Dr. Alan Anthony, a DEQ staff member in the risk assessment office, plans to perform a limited risk assessment on the collected data. In the future, should new technology become available and additional funding provided, VADEQ may conduct further studies on additional health/risk evaluation and monitoring of other type of pollutants.

Attachment 1:
Comparison with VOC data collected at other locations

The following table includes annual average concentrations of VOC, which were detected at the three Urban Air Toxics Monitoring sites from 2002 to 2004 in Virginia. These sampling sites were located at Lee District Park (Franconia - Fairfax County), MathScience Innovation Center (Richmond City), and the NOAA facility (Norfolk City).

(Unit of concentration: ug/m3)

CAS#	Target Compound	Lee Park (Fairfax)			Math & Science (Richmond)			(NOAA) Norfolk		
		2002	2003	2004	2002	2003	2004	2002	2003	2004
75-71-8	Freon-12	2.86	2.57	2.62	2.77	2.62	2.62	2.82	2.62	2.57
74-87-3	Methyl Chloride	3.06	2.62	2.52	2.96	2.62	2.57	3.11	2.62	2.52
75-00-3	Ethyl Chloride	0.05	0.05	0.00	0.05	0.00	0.00	0.00	0.05	0.00
75-69-4	Freon-11	1.43	1.23	1.23	1.38	1.28	1.23	1.33	1.23	1.23
75-09-2	Methylene Chloride	0.79	0.40	0.44	1.83	0.44	0.49	0.79	0.44	0.44
76-13-1	Freon-113	0.44	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
71-55-6	1,1,1-trichloroethane	0.20	0.15	0.10	0.15	0.15	0.10	0.15	0.15	0.10
71-43-2	Benzene	1.14	1.19	0.99	1.23	1.38	1.23	1.33	1.23	1.09
56-23-5	Carbon Tetrachloride	0.44	0.40	0.44	0.40	0.40	0.40	0.40	0.40	0.40
78-87-5	1,2-Dichloropropane	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
108-88-3	Toluene	1.43	1.58	1.38	2.32	2.27	2.07	1.78	1.93	2.62
127-18-4	Tetrachloroethene	0.25	0.20	0.20	0.15	0.15	0.15	0.15	0.15	0.15
108-38-3	m&p-Xylene	0.69	0.59	0.59	0.69	0.74	0.84	0.94	0.89	0.99
95-63-6	1,2,4-Trimethylbenzene	0.20	0.25	0.25	0.25	0.40	0.40	0.35	0.49	0.49
87-68-3	Hexachloro-1,3-butadiene	0.00	0.05	0.00	0.00	0.05	0.00	0.00	0.05	0.00

Attachment 2:**Summary Statistical Analysis – ug/m3****VOC samples collected at Spruance sampling site from 11/1/2006 to 12/31/2008**

CAS #	Pollutants	N	Detection Rate	Minimum	Maximum	Median	Average	STD
115-07-1	Propylene	2	1.5%	0.911	1.358	1.135	1.135	0.316
75-71-8	Freon-12	128	98.5%	0.494	3.507	2.470	2.494	0.494
74-87-3	Methyl Chloride	130	100.0%	0.248	1.650	1.134	1.150	0.254
75-00-3	Ethyl Chloride	1	0.8%	0.448	0.448	0.448	0.448	0.000
107-02-8	Acrolein	45	67.2%	0.183	2.015	0.527	0.581	0.333
75-69-4	Freon-11	124	95.4%	0.954	2.413	1.515	1.505	0.252
75-09-2	Methylene Chloride	76	58.5%	0.277	1.665	0.416	0.471	0.236
76-13-1	Freon-113	102	78.5%	0.536	2.832	0.842	0.901	0.368
100-54-3	Hexane	39	30.0%	0.282	4.119	0.739	0.812	0.641
141-78-6	Ethyl Acetate	1	0.8%	0.612	0.612	0.612	0.612	
71-43-2	Benzene	105	80.8%	0.255	1.021	0.542	0.557	0.204
56-23-5	Carbon Tetrachloride	95	73.1%	0.503	4.336	0.628	0.707	0.431
79-01-6	Trichloroethylene	1	0.8%	1.020	1.020	1.020	1.020	
142-82-5	Heptane	19	14.6%	0.328	1.678	0.573	0.644	0.335
79-00-5	1,1,2-Trichloroethane	1	0.8%	0.818	0.818	0.818	0.818	
108-88-3	Toluene	124	95.4%	0.301	5.270	0.847	1.055	0.760
127-18-4	Tetrachloroethene	8	6.2%	0.542	4.539	1.253	1.575	1.331
100-41-4	Ethylbenzene	16	12.3%	0.347	0.737	0.434	0.477	0.125
108-38-3	m&p-Xylene	57	43.8%	0.347	2.603	0.651	0.759	0.429
95-47-6	o-Xylene	19	14.6%	0.347	0.737	0.477	0.493	0.134
622-96-8	1-Ethyl-4-methylbenzene	2	1.5%	0.491	0.835	0.663	0.663	0.243
95-63-6	1,2,4-Trimethylbenzene	33	25.4%	0.393	1.375	0.687	0.757	0.296
541-73-1	1,3-Dichlorobenzene	1	0.8%	1.081	1.081	1.081	1.081	
106-46-7	1,4-Dichlorobenzene	14	10.8%	0.480	2.402	0.841	0.974	0.555
95-50-1	1,2-Dichlorobenzene	1	0.8%	0.661	0.661	0.661	0.661	
120-82-1	1,2,4-Trichlorobenzene	1	0.8%	3.855	3.855	3.855	3.855	
87-68-3	Hexachloro-1,3-buadiene	1	0.8%	1.491	1.491	1.491	1.491	

Attachment 3:**Summary Statistical Analysis – ug/m3****Acrolein in samples for 2 sites through 9/30/2008 and from Spruance 11/1/2006 to 12/31/2008**

	Total samples	N	Detection Rate	Min	Max	Median	Average	STD
Rice Ctr.	52	26	50.00%	0.27	2.43	0.62	0.68	0.42
Spruance	67	45	67.16%	0.18	2.02	0.53	0.58	0.33
Woodson	52	29	55.77%	0.25	1.56	0.71	0.72	0.36

Attachment 4:**Acrolein - Average Concentration Comparison – ug/m3****Including samples collected at Spruance and Woodson sites from 10/1/2008 to 12/31/2008**

The following table compares concentrations of Acrolein measured by method TO-15 in Hopewell with the Acrolein data collected at the existing Virginia Urban Air Toxic sampling sites. The data for the Rice Center runs from Jan 1, 2008 to September 30, 2008 and the data from the Spruance and Woodson sampling sites was collected from January 1 to December 31, 2008.

The data is presented in 4 different methods for handling non-detectable samples: None – no non-detectable information used in the calculation; MDL = 0 – non-detectable data entered as zero; 1/2 MDL – non-detectable data is included as 1/2 the Method detection level. MDL – non-detectable data is included as the Method detection level. The urban toxics sites are as follows:

Fairfax:	Lee District Park	Lee
Richmond:	MathScience Innovation Center	MSIC
TRO:	DEQ Tidewater Regional Office	Virginia Beach

Value assigned to non-detected sample	Hopewell Project			UATM		
	Woodson	Spruance	Rice	Fairfax	Richmond	TRO
None	0.649	0.581	0.684	0.368	0.576	0.388
Zero	0.436	0.428	0.386	0.344	0.526	0.380
1/2 MDL	0.447	0.438	0.402	0.345	0.528	0.380
MDL	0.459	0.447	0.417	0.346	0.531	0.381